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THE ORIGIN OF VERTEBRATES.

The Origin of Vertebrates. By Dr. Walter Holbrook Gaskell, F.R.S. Pp. iv+537; 168 figures. (London: Longmans, Green and Co., 1908.) Price 21*s.* net.

TWENTY years ago the author of this interesting book was led by his studies on the innervation of the heart to make a comparison between the central nervous system in vertebrates and that in appendiculate invertebrates. This led him to a highly original theory of the derivation of vertebrates from an arthropod stock, and the researches of twenty years have strengthened his confidence in this conclusion. Encouraged by what Huxley wrote to him in 1889, "There is nothing so useful in science as one of those earthquake hypotheses, which oblige one to face the possibility that the solidest-looking structures may collapse," Dr. Gaskell has published paper after paper in support of the view that the infundibulum may represent the old œsophagus, the ventricles of the brain the old cephalic stomach, the canal of the spinal cord the long straight intestine, the cranial segmental nerves the infra-œsophageal ganglia, the cerebral hemispheres and optic and olfactory nerves the supra-œsophageal ganglia, and the spinal cord the ventral chain of ganglia.

"Not having been educated in a morphological laboratory and taught that the one organ which is homologous throughout the animal kingdom is the gut, and that therefore the gut of the invertebrate ancestor must continue as the gut of the vertebrate, the conception that the central nervous system has grown round and enclosed the original ancestral gut, and that the vertebrate has formed a new gut, did not seem to me so impossible as to prevent my taking it as a working hypothesis, and seeing to what it would lead."

As is well known, there are various rival theories as to the origin of vertebrates, though the prevalent position is agnostic. Thus an attempt has been made to derive vertebrates from annelids by supposing a reversal of surfaces, but the author regards the difficulties of this hypothesis as "insuperable." On another view the annulate and the vertebrate types had a separate origin; in the former, the digestive tube pierced the central nervous system and was situated dorsally to its main mass; in the latter, the segmented central nervous system was situated from the first dorsally to the alimentary canal, and was not pierced by it. According to Gaskell, this theory does not explain the tubular appearance of the central nervous system. This, which seems to some an unimportant architectural consequence of the mode of development from a medullary groove, is to Gaskell a recapitulation of the way the nerve cord grew round the old gut. Gaskell also says that the extraordinary resemblance between the structure and arrangement of the central nervous systems of vertebrates and arthropods is against the view of their phyletic distinctness. But, given segmentation in two distinct types, we naturally expect similarity in the general plan of innervation.

Dr. Gaskell thinks that the nervous system furnishes the most important clues to relationship, and arthropods alone possess a central nervous system closely comparable with that of vertebrates. "The vertebrate tissues resemble more closely those of the arthropod than of any other invertebrate group." Argument from analogy "compels one to the conclusion that the fishes arose from the race which was dominant at the time when the fishes first appeared," i.e. from the Palæostraca. And do not the ancient fishes, like Pteraspis, Cephalaspis, and Pterichthys, resemble in a remarkable manner members of the Palæostracan group, "so that again and again palæontologists have found great difficulty in determining whether a fossil is a fish or an arthropod"? Thus various lines of argument indicate the origin of vertebrates from arthropods, or, more precisely, that the vertebrate was formed from the Palæostracan without any reversal of surfaces, but by the amalgamation of the central nervous system and the alimentary canal. The vertebrate's cerebral hemispheres and basal ganglia correspond to the supra-œsophageal ganglia of the arthropod, the crura cerebri to the œsophageal commissures, the infra-infundibular part of the brain to the sub-œsophageal ganglia, the infundibular tube to the œsophagus, the third ventricle to the cephalic stomach, the canal of the spinal cord to the intestine. The vertebrate's gut is, of course, a new formation "necessitated by the urgency of the case." Its homology with the invertebrate gut is a morphological illusion. It is only an analogue.

All sorts of difficulties rise in the mind as one considers this hypothesis, but the author is nothing if not ingenious in meeting them. Our old clues—through lancelets, tunicates, and enteropneusts—are brushed aside, and the ammocœte—so peculiar in many ways—is trusted to as the lowest perfect vertebrate. The highly specialised character of Limulus and the Palæostraca would deter many from looking to them as even near probable originators; but this is not the author's view. If the infundibular tube be "œsophagus," the third ventricle "cephalic stomach," the spinal canal "intestine," and the neurenteric canal the old way to the anus, we land in difficulties which seem to us as insuperable as those of the reversal hypothesis seem to the author. We want to know, for instance, where the arthropod's mesenteron has gone. But this is only one of the most obvious difficulties, and it is no difficulty to the author, who throws the germ-layer theory overboard as a morphological anachronism, a survival of a dogma due to the lively imagination of Haeckel.

In his second chapter Dr. Gaskell finds support for his thesis in the eyes. The pineal gland represents a pair of median eyes; Ostracoderms had median as well as lateral eyes; so has the king-crab, and so had Eurypterids. The inverted retinas of the vertebrate lateral eyes find their counterpart in the lateral eyes of arachnids, and the Palæostraca were ancestral to both. But do not the vertebrate lateral

eyes develop characteristically in the most intimate connection with optic diverticula from the neural tube? Dr. Gaskell meets this objection by insisting that the retina and optic nerve were originally outside a non-nervous tube—an anterior diverticulum on each side from the alimentary canal—and he remarks :—

"It is again a striking coincidence to find that Artemia, which with Branchipus represents a group of living crustaceans most nearly related to the trilobites, does possess two anterior diverticula of the gut which are in extraordinarily close relationship with the optic ganglia of the retina of the lateral eyes on each side."

We are accustomed to think of arthropods as typically provided with a chitinous exoskeleton, and thus contrasted with vertebrates, which have an internal skeleton of cartilage or bone. But Dr. Gaskell shows that this difficulty "vanishes into thin air" before the discovery of the branchial cartilaginous bars of Limulus, together with that of the internal prosomatic plastron. He quotes Schmiedeberg, who pointed out that glycosamine is a bridge between chitin and chondrin. The Palæostraca were the dominant arthropod race when vertebrates first appeared, and "not only had they manufactured an internal cartilaginous skeleton, but they had got it both in structure and position, exactly at the stage at which the vertebrate skeleton starts." This almost sounds like proving too much, yet it does not account for the vertebrate's dorsal axis.

Morphologists are accustomed to lay some emphasis on the branchial clefts of vertebrates, but Dr. Gaskell thinks of the branchial unit as a gill-bearing appendage, and does not hesitate to describe in ammocœtes a respiratory chamber into which a symmetrical series of sunk-in branchial appendages, the so-called diaphragms, are dependent. Two large longitudinal venous sinuses in Limulus correspond to the two veins which come together to form the heart and ventral aorta of the vertebrate. Morphological dogmatism is startled by the homology between the breathing organs in king-crab and lamprey, but it is shocked by the derivation of the thyroid gland from the palæostracan uterus—a derivation the violence of which, as it seems to us, is not lessened by the light it sheds on the mysterious physiological nexus between the sexual organs and the thyroid in man and other animals. The nasal tube of ammocœtes corresponds to the olfactory tube of a scorpion-like animal, and the pituitary body shows by similarity of structure, as well as of position, that it arose from the coxal glands, which were situated at the base of the four endognaths. Special sense-organs, such as are found in the flabellum of Limulus and in the pectens of scorpions, may be looked upon as giving origin to the vertebrate auditory apparatus. Even more surprising than these conclusions is the ingenuity of the evidence that the author uses in support of them.

We cannot follow Dr. Gaskell in his detailed comparison of segments, nerves, and musculature in vertebrates and arthropods, but we must direct attention to the twelfth chapter, where the difficulties suggested by the characteristic segmental excretory organs of vertebrates and by the state of the cœlom in arthropods are dealt with. The author shifts off from the Palæostraca to the hypothetical Protostraca —ancestral to both arachnids and crustaceans—which possessed in every segment a pair of appendages and a pair of cœlomic cavities, each with excretory organs or coxal glands. The hypothetical Protostraca arose from the polychætes. As to the notochord and the vertebrate gut, the author starts from a trilobite-like animal with a deep ventral groove and pleural fringes; the groove becomes a tube, and sinks in as the notochord; a continuation of the same process of ventral groove-formation, combined with the obliteration of appendages and the growth of pleural folds, leads to the closed vertebrate gut. All seems consistent with an earthquake-hypothesis.

In his extremely interesting fourteenth chapter, Dr. Gaskell shows that the development of a vertebrate, *e.g.* as regards nerve-tube, branchial skeleton, cranial segments, and excretory organs, reads like a recapitulation of the steps which led long ago from arthropod to vertebrate. He also expounds the suggestive view that a very much more important embryological idea than that of the three germinal layers is that which centres the metazoan body in the nervous system, and not in the gut. In the body there are master-tissues —all the neuro-muscular and neuro-epithelial structures—and within the meshes of these there are germ-cells, blood-corpuscles, lymph-corpuscles, connective-tissue cells, &c., living a symbiotic existence independent of the central nervous system.

The author regrets that his previous publications bearing on the palæostracan origin of vertebrates have not been adequately criticised. We suppose that this is because the author pays no heed to the conventional canons of morphological work. We may say that the known Palæostraca are much too highly specialised animals to be regarded as plausible starting-points for a new phylum, but the author does not share this view. We may say that the ammocœte is a very peculiar larval chordate type, likely to mislead, and that it is quite illegitimate to ignore the hints offered by Amphioxus and the tunicates; but the author does not agree. The author makes out a seemingly strong case by showing extraordinary and unsuspected resemblances between ammocœte and king-crab, and there is no use criticising these in a general way. The supposed homology of the branchial cartilaginous bars in king-crab and in ammocœte—to take one instance—must be examined in detail by an unprejudiced expert. We wish simply to point out that the ingenious author flits a little from type to type; arachnids are called in where crustaceans will not help; Peripatus is summoned when the Palæostraca prove broken reeds; and, after all, the author takes refuge in the hypothetical Protostraca, which have a good deal of the annelid about them. We do not think that the author gets over the difficulties presented by the vertebrate's gill-slits, notochord, cœlom, ventral heart, and so on, but we agree that there are difficulties in face of every attempt to affiliate vertebrates to an invertebrate stock. The question is as to which theory presents least difficulty

—if, indeed, any theory is legitimate. As we have already indicated, we are of opinion that Dr. Gaskell's theory is fatally condemned because, as he says, it makes the assertion that what was hypoblast in the arthropod has become epiblast in the vertebrate, and what was epiblast in the arthropod has become hypoblast in the vertebrate. But Dr. Gaskell thinks that the germ-layer theory argues in a vicious circle, and he practically throws it overboard—which we are not prepared to do. Yet this makes criticism very difficult.

No one can read this book without being impressed with the author's audacious ingenuity, with his patient following up of clues into remote recesses, and with the good humour with which he holds his *unus contra mundum* position. Whether he is right or wrong, he has written an entertaining book and found out a lot of interesting things by the way. We cannot pass from the book without feeling the precariousness of pedigree-construction and the need for some re-statement of the principles of morphology. Perhaps we should also recall the fact that if it be impossible to attach the vertebrate phylum with even plausibility to annelid or arthropod or any other stock, a more modest inquiry remains—How, from what we know of invertebrates, can we conceive of the origin of the various characteristic vertebrate features? To this inquiry, which seems to us more promising and profitable than the search for a lost pedigree, we think that this fascinating book has made several noteworthy contributions.

AN INSULAR FLORA.

Botany of the Faeröes. Based upon Danish Investigations. Published by the aid of the Carlsberg Fund. Vols. 1–3. Pp. xxviii + 1070; illustrated with 24 plates and 202 figures in the text. (Copenhagen and Christiania: Glydendalske Boghandel, Nordisk Forlag; London: John Wheldon and Co., 1901–1908.)

ANY addition to our knowledge of the natural history of the islands on the north-west fringe of Europe must be welcome. Most people know little more of one such group—Faeröe Islands—than that they are somewhere in the North Atlantic. There are eighteen islands in all, lying, mostly more or less befogged, in 62° N. lat. and 70° W. long., at the meeting point of a warm Atlantic current with a cold polar one from the east coast of Iceland. They are nearer the Shetlands (300 kilos. distant) than Iceland (480 kilos. distant). They are all basaltic in origin. The basalt occurs in horizontal beds, contains 10 per cent. of lime, and weathers easily. There are 15,000 people and 100,000 sheep on them. Their mountains are 3000 feet in height, and are still unexplored for the most part. The average annual temperature is 6·5° C., the winter being mild, and summer cold, with rapid changes. There are 23 per cent. dry, 12 per cent. calm, and only 5 per cent. clear days in the year.

In the work before us, Prof. Warming and his Danish colleagues have given, within the limits of 1100 octavo pages, in an excellent English translation, with very few slips, a model survey of the flora of the islands, on the practical completion of which (begun in 1896) they are to be congratulated. Not the least valuable feature in the publication is the large series of beautiful illustrations, some of which, reproduced on a larger scale in the "Vegetationsbilder" of Karsten and Schenk, are the best photographs of marine algæ the writer has seen.

The many contributions to the report do justice to the work of Lyngbye and other early investigators. After a short historical introduction by Warming, Ostenfeld devotes a hundred pages to the description of the geology and physical geography of the islands. We are reminded of the island of Heligoland, which, like the Faeröes, is being worn away on its west and north-west coasts by the sea, so that, in both cases, in the course of time the islands will disappear. In the case of the Faeröes subsidence is contributing to this result.

In a short review it is impossible to do more than mention the work of the various experts. In the lists of each group there are valuable notes accompanying many of the species, as well as general conclusions and comparisons with the distribution of the same group in Norway, Iceland, and Scotland. The comparison with the flora of the Shetlands, especially of the lower groups of plants, is vitiated by the incompleteness of the information available. In one case the Danish observer visited the Shetlands to collect the information needed for the comparison.

Broadly speaking, the conclusion on each group of plants studied is that the islands have such a flora as their geographical position would lead one to expect—a touch of the subarctic type found in Iceland and North Scandinavia, with, in the main, the temperate-European and Atlantic types. The hawkweeds (twenty-one species and two varieties) examined by H. Dahlstedt are all endemic; half of them are of the Atlantic type, and post-Glacial in origin. The vascular plants are dealt with by C. H. Ostenfeld, who, in vol. i., treats of their distribution, and in vol. iii. makes a valuable contribution to plant-ecology. This account has been also issued as a separate work, and includes an account of Raunkiaer's biological types, which are based on the selective adaptation of plants by bud protection to unfavourable climatic conditions. There are 298 vascular plants (flowering plants and ferns), and of these 90 per cent. are herbaceous perennials. There are no trees on the islands, and only fourteen species at all woody. Two of these are *Dryas octopetala* and *Salix herbacea*. The illustrations (*e.g.* that on p. 904, showing how the hapaxanthic *Cochlearia officinalis* becomes perennial) are excellent.

C. Jensen describes in his enumeration of the 391 forms of Bryophyta one new species, *Pohlia faeröensis*, and many new varieties. Sphagnum is well represented, and peat occurs on nearly every island. There is also some coal of inferior quality. The lichens, 220 species as listed by Branth, are generally stunted, due in part to competition with the mosses which thrive in the moist climate, and in part to the strong winds and the browsing sheep. E. Rostrup records

seven new species of fungi. This group is the least fully dealt with. Perhaps this is due to its comparative economic unimportance in the Faeröes, where the agriculture is in a very backward state. Thus the land, as is still the case in some parts of the west of Ireland, is too often allowed to seed itself after a barley crop.

F. Börgesen describes 323 species of fresh-water algæ, exclusive of diatoms, showing a comparatively rich flora. The fresh-water diatoms listed by E. Östrup number 269. This writer also reports on the marine diatoms, and sees in them no slight resemblance to the coastal diatoms of Greenland. The marine algæ are very thoroughly considered by F. Börgesen. His accompanying notes and figures are valuable, and his report deserves publication as a separate treatise for the sake of algologists. *Fucus serratus* and *Saccorhiza bulbosa* do not reach the Faeröes. *Halosphaera viridis* is plentiful. Several perforating algæ are recorded.

In the discussion of the origin of the Faeröese flora there is a healthy difference of opinion. Warming and others decide in favour of the view of its origin by the agency of wind, ocean currents, and migrating birds. Others, including Ostenfeld and Jensen, believe that the flora arrived along a post-Glacial land-bridge from Scotland. Sufficient has, we hope, been said to show that the Danish botanists have prepared a satisfactory account of the flora of the Faeröes, and, in addition, have made an important contribution to the study of phytogeography and plant ecology. T. J.

SCIENCE TEACHING IN GERMAN SCHOOLS.

Sammlung Naturwissenschaftlich-pädagogischer Abhandlungen. Edited by Prof. O. Schmeil and Prof. W. B. Schmidt. Bd. ii. (Berlin: B. G. Teubner, 1908.) Price 12 marks.

THE volume contains eight essays dealing with various scientific subjects—chemistry, natural history, &c.—from the schoolmaster's point of view—that is to say, the writers are concerned with the organisation of the school curriculum and with the problem of how to make their respective subjects appeal to boys, or, perhaps, as a German would prefer to put it, how to make scientific instruction educative. Whilst the essays are entirely independent of each other, several of them are written from the Herbartian standpoint, which means that a writer on chemistry in the school is not satisfied with discussing the question of his immediate business—giving the boys an understanding knowledge of chemistry—he must also discuss the relation of the subject and the method of its presentation, to the formation of character, under which head much that the average Englishman would take for granted is somewhat sententiously set forth.

The leading place in the volume is given to an article on the importance of experiment in the teaching of chemistry. We should not expect to find anything of the kind in an English book, for the simple reason that, both in theory and in practice, we have long since abandoned the attempt to teach science in the schools without well-equipped laboratories and lecture-rooms. Rightly or wrongly, the German taxmaster has not felt justified in calling upon the people to provide the costly apparatus necessary. Four years ago it was possible to find even a Berlin *Oberrealschule* almost destitute of all we regard as *sine quâ non* for the adequate teaching of science. Of course, the German will reply that it has not been a question of parsimony in education. What has been saved in the schools has been spent in the scientific equipment of the universities. The question of where the money may be most advantageously laid out is one which we have not, perhaps, considered very carefully, or, having considered it, those who decide these matters have come to a conclusion strikingly different from that of Prussia and other German States.

What is true of the higher schools of Germany is true also of the training colleges, in many of which there is no provision for practical work in science. The fact that the elementary-school teachers had no acquaintance with the handling of scientific apparatus led a recent advocate of chemistry in the primary school to make a rather quaint suggestion. Why should the teachers not avail themselves of the facilities afforded by the nearest chemist's shop? There they might learn the art of experimentation so far as it is necessary to the teaching of the elementary facts of the subject. It does not appear that the suggestion has found favour in the eyes of the teachers!

Some of the most interesting essays in the volume are concerned to change the character of school science from that of a mere accumulation of facts selected and systematised from a restricted standpoint to a form in which the work is directed to the realisation of a great general principle, or in which procedure is determined by the question of what general problems are accessible to the minds of the pupils at various stages in their intellectual development. Particularly interesting in this regard is the one entitled "Der dynamologische Lehrgang," in which the author sketches at considerable length a course of science for boys from eleven to fourteen. Nature is always a happening, a becoming, or a dissolving, and nature knowledge is really nothing else than clearness concerning processes—growing, breathing, blossoming, fading away. Indeed, every object in nature is a summation of processes, and only when we regard it in this way can there be a scientific study of nature.

In school, particularly, the science-teacher is to keep the unity of nature steadily before the children's minds, and he should frame his syllabus to bring out the connectedness of natural phenomena in a systematic way. The botanist does not usually regard a knowledge of the movements of the air as an essential preliminary to lessons on modes of fertilisation, nor would a teacher dealing with air-currents and their causes usually treat the subject from the point of view of a great source of energy which is essential to many natural processes. Each science as such takes its facts out of their natural surroundings and

puts them into a logical system more or less complete within itself, and the young student often completely misses the relation of that which occupies his mind to the universe as a whole. The author has worked out his idea in an ingenious and suggestive way.

It is impossible in a brief notice to deal adequately with the volume as a whole. In many points it shows that the writers are dealing with a condition of things that has really passed away in our country. For example, we should expect a sentence like this in an English book of a generation ago :—

"The reform we are advocating calls for nothing less than a fight *à outrance* against verbalism in every form. Such a battle could issue in nothing but good. Writers on the teaching of science have begun it already, but the old mistakes and prejudices are not easily overcome."

Whilst there is not doubt that in the material equipment of our schools on the scientific side we are a long way ahead of the Germans, it still behoves us to remember that verbalism is not impossible side by side with lecture experiments and laboratory courses. It is the "carrying idea" that gives vitality to what the boys are doing—whether it be essay-writing or using a balance. There is still a good deal of misunderstanding in regard to this matter. Sensory accessories do not constitute the difference between the real and the verbal.

J. A. GREEN.

COUNTY GEOGRAPHIES.

Cambridge County Geographies:—Essex. Pp. viii+167. *Kent.* Pp. viii+146. *Surrey.* Pp. viii+151. *Sussex.* Pp. viii+144. By G. F. Bosworth. (Cambridge: University Press, 1909.) Price 1*s.* 6*d.* each.

THE idea of this series is excellent. A series of elementary geographies, each dealing with a single county, obviously ought to exist. The present volumes are all on one model, and the model is good. First a short survey of the origin of the county under notice, and of its name, is given. Its extent, relief, river-system, geology, natural history, and climate follow. Next the population and industries are dealt with; then the history of the county, its antiquities, its communications past and present, its administrative divisions ancient and modern, and the roll of famous men born within it. Finally there is an alphabetical gazetteer of the chief towns and villages (which, it may be added with regret, is the nearest approach to an index provided in the volumes). Following the text are certain diagrams showing density and other features of population, and agricultural conditions. At the beginning of each volume is a map (by Messrs. Philip) showing the relief of the land by the flat-colour contour system, and at the end another map, the same in outline, but coloured according to geological formations.

Here, then, is an excellent skeleton, and on the whole it is well clothed. Of details of the clothing, however, some criticism may be offered. If we rightly apprehend the purpose of the series, the treatment of the relief of the land appears to have been given less prominence than is perhaps its due, while the geology—a subject which, in its strict sense, cannot appeal to a large circle of students—is given proportionately too much. In each volume the remarks introductory to some of the subjects differ hardly at all save in wording. This may have been inevitable, though it might have been thought sufficient to infer the reader's acquaintance with the generalities of each subject. At any rate, it is a matter for congratulation that in the introductory remarks on climate common to all the volumes, the faint praise of the Meteorological Office's weather forecasts, "which are often correct," only occurs in one instance. Some of the sections deserve special commendation—the notices of the history of the counties and their architectural and other antiquities may be indicated.

The illustrations are partly from photographs and partly from line drawings. In each case the reproduction is well carried out. The architectural photographs are the best as a class. One would have welcomed a better attempt to illustrate characteristic land-forms, and in any case photography is a better medium for illustrating a work of this sort than line drawings, which in the present cases are not wholly successful. The maps are bound in on the excellent plan of attaching half of each one completely to the cover of the book—a good method of preserving them. Considered cartographically, while otherwise very fair, they have the somewhat serious fault of showing no physical features or geological formations beyond the confines of the county dealt with, so that they do not help in considering the county in relation to its surroundings, as the text very properly does.

But after these remarks it should be said that the series is well conceived, and so far well produced, and deserves success.

O. J. R. H.

SOLID AND PLANE GEOMETRY.

(1) *Practical Solid Geometry.* By the Rev. P. W. Unwin. Pp. xii+267. (London: G. Bell and Sons, 1909.) Price 4*s.* 6*d.*

(2) *Cassell's Elementary Geometry.* By W. A. Knight. Pp. vii+253. (London: Cassell and Co., Ltd., 1909.) Price 2*s.* 6*d.*

(1) THIS volume deals with the orthogonal projections of solids and of their plane sections, with explanations of figured plans and scales of slope of planes, followed by a chapter on metric or parallel pictorial projections, and one on miscellaneous problems.

It is an excellent book, well graduated, with clear though concise explanations of the numerous fully worked problems, and seems to be remarkably free from misprints for a first edition.[1] It should well fulfil the author's desire to make his readers "think in space." This volume is arranged to cover Stage 1

[1] We have found only one, viz. on p. 102, l. 4, where H.P. should be V.P

of the Board of Education Examination, and to meet the requirements of Army candidates. In the chapter on parallel projection, the theory on which it depends, viz. that it is the view, *on the YZ plane*, of the solid and the various coordinates *and* the co-ordinate axes, obtained by parallel rays inclined to that plane at some specially chosen angle, is not put quite so clearly as perhaps it might profitably have been, but the author expressly says that the theory is to be dealt with in the second volume, which is in course of preparation, and the chapter in question very clearly shows how the constructions are to be made and used for measurements. The sentence on p. 92, lines 13–16, contains an erroneous and incomplete argument, very unlike the author's usual careful accuracy. The sentence as it stands implies that vertical planes are necessarily perpendicular to horizontal lines.

There is a useful appendix on algebraic solid geometry, dealing with planes and lines, as far as the tangent plane to a sphere, and two other appendices give the requirements of the Board of Education in solid geometry and some sets of its papers.

There are a good number of examples attached to each chapter for the student to solve, and we are glad to see a good index, which greatly facilitates reference.

(2) It is difficult for the writer of a geometrical text-book for beginners to decide how much of the philosophy underlying the subject should be given. The author's treatment of the straight line and of parallel straight lines is not satisfactory. He defines a straight line as the shortest distance between two points, but makes no use of that definition in the text, and parallel straight lines are defined as straight lines drawn in the plane in the same direction. It may be contended that this is sufficient for young students, though it certainly will not satisfy all teachers. It is, however, an appeal to common notions, and, after all, a good many propositions do depend on these, however carefully the philosophical foundations may be laid. A more serious defect is where the author, after proving, by means of opposite rotations, that lines are parallel when the alternate angles are equal, promises another proof, and eventually gives one which depends on a proposition deduced from the previous one, a most flagrant case of reasoning in a circle.

The author has adopted the excellent plan of elevating a number of standard problems and theorems into the text which are usually only given as riders, and though occasionally we would have liked to see slightly different methods of construction or of proof, on the whole they are complete and clear, and the propositions are accompanied by a good number of well-chosen exercises. The range of the book is as far as the end of the sixth book of Euclid, with the omission of one or two propositions at the end. We cannot, however, find the very important proposition on which the proofs of the properties of similar triangles depend, viz. that if one transversal is divided into equal parts by a series of parallel straight lines, all transversals are also divided by them into equal parts. The nearest approach to this is on p. 84, where a construction is given for dividing a line into equal parts, but it is merely said that "it is easy to show" the congruence of certain triangles, &c. The full proof should have been given, or, better still, the construction should have been preceded by the general theorem. Of course, the teacher can supply the omission, but it is notorious how young students usually fail to remember proofs which are not in their text-book.

OUR BOOK SHELF.

The Story of Gold. By E. S. Meade. Pp. xv+206; illustrated. (London: Appleton and Co., 1909.) Price 2*s.* 6*d.* net.

THE author of this book appears to believe that all human progress depends on a continuous rise in prices, that a rise in prices is always due to a great addition to the stock of gold in the world, and that consequently it behoves statesmen to see that gold is produced from the mines in a rapid and increasing stream. Rome decayed because the Spanish mines stopped producing. Europe weltered in misery until 1492 because the stock of precious metals continued to diminish. Thereafter all went well until about 1810. (N.B.—The price of wheat in 1809 was 157*s.* per quarter, with wages much lower than now.) Then the revolt of the Spanish American colonies cut off the production of the mines, and began a period of stringency which was not relieved until after 1849. From 1873 to 1896 the new gold supplies were again inadequate, prices fell, trade was bad, the human race languished. Then for a time the enormous production of gold allowed progress to be resumed. The pace, however, is rapidly becoming hotter. Although the output of gold is even more enormous now and is still increasing, the supply of other commodities has overtaken it, and unless the gold miners redouble their efforts there is little chance of a revival of prosperity.

The author is a professor of finance of the University of Pennsylvania, and consequently his discussion of geological, chemical, and engineering problems connected with gold need not be taken seriously. Nevertheless, a long succession of careless misstatements such as appear in the book becomes wearisome, and creates an atmosphere of prejudice against the author, so that his most lugubrious predictions and stirring calls to action leave the reader unconvinced and apathetic. Even when his information is correct, the author's utterances are somewhat cryptic, *e.g.* "Gold is remarkable for its freedom from corrosive solutions."

His main thesis is, of course, tinged with exaggeration. There is no doubt that rising prices benefit all those who buy to sell again, including speculators as well as merchants. How far the whole community benefits is not quite so certain. It is often contended that a flat level of prices would be best of all. Moreover, it is hardly fair for the representative of almost the only nation still addicted to frenzied finance to attribute its disasters to those laggards the gold miners.

There is no need to be pessimistic as to the adequacy of the supply of gold, but if it really became scarce, it is perfectly obvious to unprejudiced observers that gold need not be retained as the sole medium of exchange. In a sense most of its work is done already by cheques, bank notes, silver, and the like. Although in earlier times it was prized for itself alone, it is now of very little intrinsic value. It

retains its place by a convention which remains valid owing to the force of long-continued custom. If the fluctuations in prices as measured by it became too great, it would have to be discarded as a standard of value. T. K. R.

Artificial Waterways and Commercial Development (with a History of the Erie Canal). By Dr. A. Barton Hepburn. Pp. ix+115. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1909.) Price 4*s.* net.

AFTER a long period of effacement, artificial waterways are beginning to regain some amount of public interest and concern. The advent and rapid development of railways during the last century was responsible for their relegation into a background of indifference and neglect, and so long as men's minds were dominated by schemes of rapid locomotion at any cost, it was difficult, and, in fact, impossible, for canals to maintain any footing in competition with a system of transit infinitely more expeditious and direct. But a change is taking place in public feeling. It is being recognised that canals have been at an undue disadvantage, and that, as a means of locomotion, they possess features which merit encouragement and development. Inland water carriage for goods, though slow, is safe and cheap, and canals possess a striking advantage over railways in that, in place of isolated depôts at long intervals, they possess a continuous frontage workable throughout their entire length. On these and other grounds, public interest in canals has been aroused, and a Royal Commission in this country has lately had under consideration the means best adapted for their revival and amelioration.

Dr. Hepburn's book is a timely contribution to the evidence on the subject. Written from an American standpoint, it constitutes an appeal to the citizens of the United States in regard to the development of their artificial waterways. It recites in brief compass the principal historical facts connected with canals throughout the world, and then proceeds to consider in more extended detail the canal system of New York, describing its inception, development, and present condition. Thence the author passes, by a transition natural to a patriotic American, to an account of the Panama Canal, with its vicissitudes and possibilities. The volume closes with fifteen statistical appendices.

Hydrographical Surveying. A Description of Means and Methods employed in constructing Marine Charts. By the late Rear-Admiral Sir William J. L. Wharton, K.C.B. A new edition, revised and enlarged by Rear-Admiral Mostyn Field, F.R.S. Pp. viii+475. (London: John Murray, 1909.) Price 21*s.* net.

THE late Admiral Wharton's "Hydrographical Surveying," which has been for so many years a standard work and one of the best books for surveyors that has ever been published, has now been brought up to date by his successor, Rear-Admiral Mostyn Field, the present hydrographer to the Admiralty. Admiral Field has endeavoured to alter the text of the former work as little as possible, but at the same time to enlarge it considerably by the addition of new features, including expedients connected with work in the field which have been found useful in practice, in order especially to assist the young surveyor by directing his attention to useful methods of procedure which otherwise he would only pick up as his experience ripened. In addition to these features, all the latest improvements are fully described, such as the use of photography for the reproduction of charts, automatic tide gauges, improved instruments for observing currents and taking deep-sea soundings, and, finally, the usefulness of the Barr and Stroud range-finder for surveying purposes.

The volume as it now appears, brought thoroughly up to date and accompanied by excellent diagrams, cannot fail to be of the utmost value to all surveyors. H. C. L.

Œuvres complètes de Christian Huyghens publiées par la Société hollandaise des Sciences. Vol. xi., Travaux mathématiques, 1645–1651. Pp. iv+369. (La Haye: Martinus Nijhoff, 1908.)

THIS volume is divided into several parts. The first part deals with Huyghens's early writings (1645–6), and is preceded by an account of a manuscript by van Schooten which formed the basis of Huyghens's first mathematical studies. The writings in question deal, *inter alia*, with elementary geometrical considerations relating to the parabola and funicular polygons. The next portion consists of Huyghens's three books entitled "De iis quæ liquido supernatant" (1650), forming a collection of applications of the principle of Archimedes to floating bodies of simple shapes. A number of geometrical problems dated 1650 follow, and the volume concludes with the "Theoremata de quadratura hyperboles, ellipsis, et circuli ex dato portionum gravitatis centro" (1651). The volume is well got up, and forms an interesting contribution to the history of mathematics.

The General Characters of the Proteins. By Dr. S. B. Schryver. Pp. x+86. (London: Longmans, Green and Co., 1909.) Price 2*s.* 6*d.* net.

THIS is another of the series of monographs on biochemistry which are being issued by Messrs. Longmans under the editorship of Drs. Hopkins and Aders Plimmer. The previous monographs have been already noticed in these columns, and two of these dealt with the proteins from the more strictly chemical point of view. Dr. Schryver now adds another chapter to, and by no means exhausts, this large subject. The first section deals with the physical properties of the proteins (solubilities, crystallisation, heat coagulation, rotatory power, electrical conductivity, and so forth); the second with their general chemical characters (tests, distribution of nitrogen, compounds with acids, bases, halogens, &c.); and the third with the precipitin reaction, which is commonly known as the biological test.

The whole is treated in a technical but clear manner; references are given to the authorities quoted, and the booklet will prove a useful addition to the library of the physiologist, and should be found in every laboratory devoted to biochemical research. W. D. H.

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 Gravitative Pull upon the Moon.

THE error made by Mr. McLennan in NATURE of May 6, p. 276, is a curious one, which may perhaps be made more often than we are aware of, and therefore is worth correcting.

It is true that gravitational pull and centrifugal force both decrease as square of distance increases, each with its own cause of decrease, so as to remain equal and opposite; but then the two causes of decrease are not to be piled on to one of those forces! That is the error.

Mr. McLennan has done his arithmetic correctly, but the calculation is really extremely simple, as thus:—

The moon's mass is 1/80th that of the earth, which is 6×10^{21} tons. At the moon's distance, which is 60 earth's radii, terrestrial gravity is reduced to 1/3600th of its value at the earth's surface. Consequently, the weight of the moon, *i.e.* the earth's gravitative pull on it, is equal to the ordinary commercial weight of

$$1/3600\times1/80\times6\times10^{21} \text{ tons.}$$

An *alternative*, but not a supplementary, way of doing the sum is to say that the moon revolves through the angle 2π in, say, $27\frac{1}{3}$ days, and that therefore the centripetal force necessary to hold it in is

$$m\omega^2r=\frac{6\times10^{21}}{80} \text{ tons} \times \left(\frac{2\pi}{27\frac{1}{3} \text{ days}}\right)^2\times60\times4000 \text{ miles.}$$

The acceleration part of this is about 13,000 miles per day per day, which is the same as 32/3600 feet per second per second; and this is obviously in accordance with the law of inverse square. OLIVER LODGE.

A Direct Estimate of the Minimum Age of Thorianite.

I WISH to record an experiment lately made which affords more direct proof of the great antiquity of radio-active minerals than anything previously attempted.

The principle of the method is to determine (1) the total accumulated helium in the material; (2) the rate of formation in the *same* material at present.

A sample of thorianite was found to contain 9 c.c. helium per gram.

Four hundred grams of this thorianite was got into solution, and all traces of helium boiled out with scrupulous care. After it had been allowed to stand for seven weeks, the solution was boiled out again. A little nitrogen and nitric oxide were evolved. These were removed by charcoal cooled in liquid air, and the residual helium collected in the capillary of a McLeod gauge. D_3 could be seen in the spectrum, but the volume of the gas was too small to measure. It was certainly less than 2×10^{-6} c.c., perhaps much less.

Thus the annual rate of production of helium per gram is less than $3{\cdot}7\times10^{-8}$ c.c. The 9 c.c. initially present cannot, therefore, have accumulated in a less time than 240 million years. Experiments on a larger scale, which are in progress, will probably lead to an extension of this estimate.

Prof. Joly, in his interesting book, "Radio-activity and Geology," has brought various objections against the radio-active method of measuring geological age. These will require to be carefully weighed. I may remark, however, that in the present case no uncertainty arises on the ground that the substance may formerly have contained much more uranium or thorium than at present, for thorianite consists almost entirely of the oxides of these elements. R. J. STRUTT.

Imperial College of Science, May 11.

Sense of Smell in Flies.

BY far the most efficient of fly-destroyers with which I am acquainted is a dilute solution of formaldehyde. If two teaspoonfuls of formalin (40 per cent. formaldehyde) be added to a soup-plate filled with water, flies go to it, one after the other, to drink, especially in the early afternoon. Some die in the water; many fall in the immediate neighbourhood of the plate; others succumb on window-sill or floor. As the result of leaving a single plateful of the solution on the kitchen table (I am writing in the south of France) hundreds of dead flies are each day swept up from the floor. Formalin water is free from the gruesome associations of fly-papers and other traps which hold their struggling victims. It may even be turned to ornamental uses. A wire cage placed in the centre of the dish may be crowned with flowers, which flourish equally as well, with some slight but interesting changes in tint, in dilute formalin as in pure water. The solution neither attracts nor repels flies. Two similar dishes placed side by side, the one containing pure water and the other formalin, are visited, so far as one can judge, with equal frequency. It is somewhat strange that so small a dose proves fatal when taken into the fly's alimentary canal. I find that, to free a room from flies by vaporising formalin, the air must be rendered quite irrespirable by a human being. The room needs to be amply ventilated before one ventures into it.

The interest which attaches to this observation, that flies will drink a solution of formadehyde, lies in the proof which it affords that the mechanism of their sense of smell is similar to our own. No volatile body the density of which is not greater than that of air is a stimulant of our olfactory membrane. Formaldehyde, H,COH, has a density of 15 only. Playing in paradoxes, one might say that it undoubtedly has a malignant odour, but we cannot smell it. If the nose be placed close to a vessel containing a dilute solution of formalin a scent is recognisable, but this I take to be due (a chemist will correct me) to impurities present in the commercial product. Yet I find that when I sit within a yard of it my eyes begin to smart. In this respect, however, I am, I know, exceptionally sensitive. I cannot dissect specimens preserved in formalin until after they have been long soaked in water and spirit frequently changed. Once, when conducting a *viva voce* examination with the aid of formalin preparations, I developed so acute and painful, although happily transient, an attack of conjunctivitis as made it impossible for me to attend the examinees' meeting. The fact that so deleterious a volatile body as formadehyde does not appeal to our sense of smell would seem to confirm the only theory of the physics of olfaction at present plausible, though far from comprehensible, namely, that which attributes to the hairs of the cells of the olfactory membrane the capacity of responding to the alterations in the vibration frequency or amplitude of molecules of air which are caused by the presence amongst them of heavier molecules. ALEX. HILL.

Mentone.

The Production of Radium from Uranium.

EXPERIMENTS on which I have been engaged for the past six years have until now failed to establish the production of radium from uranium. With carefully purified uranium salts, using considerable quantities, the growth is too small to be detected for the first two or three years, and is less than 1/10,000th of what would occur if a direct change of uranium into radium took place. With commercial uranyl nitrate, on the other hand, purified from radium by precipitating barium sulphate in the solution, a distinct though small production of radium was observed in 1905, and subsequently confirmed (*Phil. Mag.*, October, 1908, 632). This is explained by the existence of an intermediate parent of radium in the series with a very long period of life, which has been found by Boltwood and by Rutherford in preparations of actinium, and recently isolated by the former from uranium minerals, and called "ionium."

I have now been able to establish the production of radium in all the solutions of very carefully purified uranyl nitrate prepared by Mr. T. D. Mackenzie and myself (*Phil. Mag.*, August, 1907, 272). Three separate solutions containing 255, 408, and 278 grams of uranium (element), and of age since purification at the present time respectively 3·53, 2·40, and 2·73 years, have been kept under observation. The method of testing has been much improved since formerly, and the error of a single determination as now carried out probably does not exceed 10^{-12} gram of radium. The quantity of radium in the oldest solution is now about 4×10^{-11} gram, which is nearly twice as great as initially. During the past year five measurements of the quantity of radium in this solution have been made, and they show that, within the stated limit of error of observation, the production of radium has proceeded during that period *proportionally to the square of the time*. The tests on the other solution show that in them also the production of radium is now proceeding according to the same law and at a similar rate.

That the initial rate of production of radium from uranium should vary according to the square of the time was deduced mathematically by Rutherford (*Jahr. Rad.*, 1908, v., 164) on the assumption that there was only one intermediate substance of period of life long compared with

the time of experiment in the uranium-radium series. It is easily shown, provided all the periods are long, that the initial rate of production must be proportional to the same power of the time as the number of substances (including uranium itself) in the series before radium. These experiments, therefore, indicate that there is only one intermediate substance in the uranium-radium series with a long period of life. Assuming what is probable, but not yet known, that the present law and rate of production will be continued in the future, it is possible to fix the period of average life of the intermediate substance from the existing data, with a margin of uncertainty probably not greater than 20 per cent. Rutherford has shown that the initial production of radium in grams from a kilogram of uranium is equal to $6\times10^{-8}\lambda T^2$, where $1/\lambda$ is the period of average life of the intermediate body in years, and T is the time in years. This gives for the average life of the intermediate body the period of 10,000 *years*. This is about four times that of radium itself, and there should exist in uranium minerals about 1·36 milligrams of the substance per kilogram of uranium. The initial rate of production over the first two years appears less than that calculated, as though another intermediate substance of period of the order of two years existed in the series; but greater refinements will be necessary before this can be definitely proved by experiments of this character.

FREDERICK SODDY.

Physical Chemistry Laboratory, University of Glasgow.

Wave Motion and Bessel's Functions.

THE property, enunciated by Dr. Johnstone Stoney, according to which any wave motion can be regarded as built up of a combination of plane waves, may be used with advantage for a verification of the formulæ for the solutions of Bessel's equation in the form of definite integrals.

Consider, for example, the hydrodynamical problem of circular waves about the axis of z in a liquid of uniform depth extending from $z=0$ up to the free surface $z=h$. Imagine the wave motion to be built up by the superposition of a continuously infinite number of plane waves, symmetrically distributed about the axis of z. By taking α to denote the angle which the normal to any wave front makes with the radius vector to any point, and by integrating the expression for the velocity potential of the corresponding train of plane waves with respect to α, we get the expression

$$\phi=A\int_{-\pi}^{\pi}\cos m\{r\cos\alpha-vt+\epsilon\}\cosh mz\,d\alpha,$$

where

$$v^2=\frac{g}{m}\tanh mh.$$

The above expression for ϕ being a solution of Laplace's equation, it follows that

$$\int_{-\pi}^{\pi}\cos m\,(r\cos\alpha)\,d\alpha \text{ and } \int_{-\pi}^{\pi}\sin m\,(r\cos\alpha)\,d\alpha$$

are solutions of the corresponding Bessel's equation in r.

Next, taking an unsymmetrical distribution of plane waves, and confining attention to the particular case in which the phase relative to the origin is independent of the direction, the amplitude between the directions α and $\alpha+d\alpha$ being $F(\alpha)d\alpha$, we find for the potential at the point (r, θ, z) the expression

$$\phi=\int F(\alpha)\cos m\{r\cos(\alpha-\theta)-vt+\epsilon\}\cosh mz\,d\alpha,$$

the integral being taken between limits for α differing by 2π. By writing $\alpha-\theta=\omega$, and suitably choosing the limits, we find

$$\phi=\int_{-\pi}^{\pi}F(\theta+\omega)\cos m\{r\cos\omega-vt+\epsilon\}\cosh mz\,d\omega,$$

and taking the particular cases of $F(\alpha)=\cos$ or $\sin n\alpha$, we obtain the solutions of Laplace's equation

$$\cosh mz\cos\text{ or }\sin n\theta\int_{-\pi}^{\pi}\cos\text{ or }\sin n\omega\cos\text{ or }\sin m\,(r\cos\omega)d\omega$$

leading to solutions of Bessel's equation of order n, namely,

$$\int_{-\pi}^{\pi}\cos\text{ or }\sin n\omega\cos\text{ or }\sin m\,(r\cos\omega)\,d\omega.$$

G. H. BRYAN.

University College of North Wales, Bangor.

Dew-Ponds.

LIKE "E. A. M." in NATURE of April 22, I have always been extremely sceptical about Mr. Hubbard's theory of dew-ponds since it first appeared in "Neolithic Dew-ponds and Cattle-ways." My own experience of lakes and ponds is that they lose their heat slowly, and that, after radiation has set in at night, they indicate a much higher temperature than the ground adjoining or the air above.

It has been a matter of frequent observation on Coniston Lake in summer that, after a night of heavy dew, the bottoms of the boats inside were perfectly dry, whilst the gunwale was covered with moisture, showing that the portion of the boat in contact with the water had been raised to a temperature above the dew-point. Prof. Miall and myself a few years ago made a special expedition to the Berkshire downs, in the neighbourhood of Wantage, to determine the temperature of the dew-ponds, and we found precisely the same thing, that is to say, the water at night was warmer than the air. It is impossible, therefore, that dew could deposit on the ponds under these conditions.

Moreover, as "E. A. M." points out, it is inconceivable that the clay or straw in a full dew-pond can have much connection with the temperature of the water. My own conviction is that the straw is merely used to bind the clay, and the bed of clay above the chalk serves no other purpose than to make the pond bottom water-tight. No satisfactory explanation of dew-ponds has yet been propounded, and, as your correspondent says, "there is room for more experiment." I have seen no reference to what may, I think, constitute one important factor in the replenishment of dew-ponds. Aitken has shown that the greater portion of the moisture deposited as dew is derived from the ground and not from the air, and in this connection it should be remembered that the chalk, on which the ponds are usually constructed, absorbs water like a sponge. Consequently, any lowering of temperature may cause a heavier dew or mist formation than on less absorbent material. Seeing that many of the ponds lie quite exposed on the very summit of the downs, drainage of dew cannot feed them, and it seems probable that mist may in some cases play a more important *rôle* than dew.

J. B. COHEN.

The Imperial Side of the Fuel Question.

THE article in NATURE of May 6, and Sir W. Ramsay's comment upon it, direct attention to a most important economic question. It has often crossed my mind that by a simple legislative enactment a marked saving might be effected in our factory consumption of coal. If Parliament would enact that after a given year, say 1920, a considerable penalty should be payable by the owner of any factory where the consumption of fuel coal exceeded 1½ lb. per hour per indicated horse-power, it is probable that almost all factories would by that date be improved up to that level of efficiency.

It is probable that the average efficiency of steam plants is only about 3 lb. per indicated horse-power hour, and your article shows the factory consumption to be about sixty-one million tons per annum. On those figures, halving the consumption on the above lines would save about thirty million tons a year. The modernisation of plant involved would pay for itself (from the factory owner's point of view) in a very few years, and so would be a remunerative investment, so much so that financing the change should be within reach of even the weaker firms.

The thirty million tons I suggest might be saved is more than 11 per cent. of the production (figures of 1907), so that the saving is well worth the attention of all who are concerned to conserve our coal, and I trust that the idea may be pressed forward in influential quarters.

Manchester, May 10. ARTHUR MCDOUGALL.

CLOUD PHOTOGRAPHS FROM A BALLOON.

THE two photographs which accompany this short note were taken during a balloon trip commencing at Battersea and terminating at Hadlow, near Buxted, in Surrey, on February 6 of the present year.

FIG. 1.—Cloud scenery from balloon at an elevation of 5800 feet. Photographed by Dr. W. J. S. Lockyer.

Leaving the ground at 12h. 24m. p.m., the wind, or what there was of it, gradually took the balloon away in a direction a little east of south. There were thick, heavy cumulus clouds hanging over London at the time, and between them one beheld the sea of houses below. At 1h. 3m. p.m., at an altitude of 4000 feet, we became fairly enveloped in one of these clouds, and some minutes later, at an altitude of 5200 feet, we emerged from its top out into the brilliant sunshine. The heat of the sun acting on the gas in the envelope gradually expanded it, and we rose to our greatest altitude of the day—namely, 7300 feet, or about 1·4 miles, reaching this elevation at 2h. 12m. p.m.

From the time the balloon was above the clouds the panorama was a glorious one to behold. The billowy tops of the cumuli stood out as white as snow in the sunshine. In the interspaces between the cloud masses there was present thin stratus cloud, which sometimes gave the appearance of lakes between snow-capped mountains or of the sea with snow-capped hills for the coast-line.

If one regarded this fine panorama in the same azimuth as the sun, the effect of contrast was most striking. The billowy cumuli were outlined in brilliant white, while the portions turned towards one were of intense blackness, and afforded a fine background for the sunbeams passing over the cloud tops. In other directions the cloudscape exhibited beautifully soft effects.

The first of the two photographs here shown (Fig. 1) was taken at 1h. 33m. p.m., when the balloon was nearly over Crookham, at an altitude of 5800 feet, or a little more than a mile high. The camera was directed nearly horizontally, and the balloon was only about 800 feet above the cloud tops. In this, one can observe the sea-like nature of the stratus cloud, bordered by the tops of the cumulus clouds, suggesting an Arctic scene.

The second photograph (Fig. 2) was taken later, at 1h. 50m. p.m., at an altitude of 6700 feet, or about a mile and a quarter. The balloon was then over the neighbourhood of Claydene, and the camera was pointed slightly down from the horizontal and in the same azimuth as the sun. This photograph shows the great expanse of the billowy cloud tops and

FIG. 2.—Cloud scenery from balloon at an elevation of 6700 feet. Photographed by Dr. W. J. S. Lockyer.

the bold contrast of the scenery, but the picture conveys only a general idea of the beauty of the scene.

After another interesting hour among the clouds, a gentle descent was made to earth at Hadlow Down, the trip lasting 2 hours 26 minutes. To escape, even for a brief interval of a few hours, from the turmoil of London, and to be, in the space of a few minutes, amongst such magnificent scenery as the view above the clouds affords, is one of the greatest fascinations of ballooning, even if one has to be carried where the wind wills. WILLIAM J. S. LOCKYER.

THE REFORM OF OXFORD UNIVERSITY.

BEFORE entering upon any discussion of the scheme presented by the Chancellor to the University of Oxford, and of the consequent action taken by the Hebdomadal Council, it is important to make a few introductory remarks on the conditions under which the effort for reform from within is about to be made.

In the first place, there is no question or debate about the inestimable value of collegiate residence. On this point all in Oxford, and it may be hoped all outside it, are agreed. Secondly, the strongest difference of opinion on questions of university policy exists, as it has existed in the past at Oxford, without the least personal feeling. It is useless to attempt to conceal the fact that under the existing system there is and must be conflict between the interests of the university and the colleges, but those who take the strongest line on the one side will be among the first to admit, nay, to proclaim, the devotion and self-sacrifice which are brought to the support of the other. In many cases, indeed, a university policy is most firmly sustained by men whose interests are bound up with the colleges. The question is what is best for Oxford, and through Oxford for the Empire, and to hold a strong opinion in such a controversy does not weaken a loyal and sympathetic cooperation with those who maintain the opposite position.

The point of view which will be maintained in the present article, and from which the Chancellor's book and the resolutions of Council will be examined, is that of the university as opposed to the colleges. We maintain that Oxford will gain as a seat of research and learning and in its influence—already beneficial in the highest degree—on the lives of its students by restoring to the university much of its ancient power and authority, and by leaving the colleges as dignified and historic homes, where, if teaching is carried on at all, it will be under the control of the university.

The first series of resolutions deals with the three governing bodies of the university—Convocation (M.A.'s who retain their names on university and college books), Congregation (such M.A.'s residing within a mile and a half of the centre of Oxford), and the Hebdomadal Council. This latter important body, by which alone legislation can be initiated in Congregation and Convocation, consists of three *ex-officio* members, the Vice-Chancellor and the two Proctors, and eighteen members elected by Congregation. Of these eighteen, six must be heads of colleges, six professors, and six M.A.'s. The power of Council will be best understood by the statement that, except on its initiative, no modification can be made in the existing examination system, no expenditure of a sum exceeding 100*l*., no loan to a reader of book or manuscript out of the Bodleian Library.

It is impossible in the brief compass of a single article to do more than sketch the broadest outlines, but it is submitted that details here necessarily omitted do not substantially modify the accuracy of the picture suggested to the reader. Thus Congregation includes, but is not substantially affected by including, a complex list of *ex-officio* members; the Chancellor is a member of Council, but is very rarely present; the Bodleian has the power of lending to the Radcliffe Library, and consequently to the readers of the latter.

Lord Curzon proposes that the three categories of Council should be given up, and Council itself has resolved so far as possible "to abolish or modify the existing division into three orders." There is no doubt that the power of the university would be seriously weakened by the abolition of the professorial category unless provision be made for university representation of some other kind. The heads are collegiate appointments, for even at Christ Church, the headship of which is in the gift of the Crown, it is customary to select a Dean from the governing body. In addition to the power given to the colleges by the presence of the six heads on Council, it should be remembered that the Vice-Chancellor must, under the present constitution, be the head of a college. The Oxford of an older day, with its greater leisure and greater freedom, gave to the colleges heads almost invariably picturesque and sometimes inspiring. In an organisation mainly developed with reference to the rush and tumble of the modern race for first-classes between the colleges, the headship of the future will generally be, if not the retiring pension, at least the pension of a retiring tutor or bursar. If it be impossible to modify this system, an effort should be made to render the income of the position more commensurate with its duties. A small increase of stipend would amply compensate for the loss of much drudgery and an acceptance of the dignified and not exacting position of chairman. In these circumstances, too, it would be beneficial to abolish the category of heads in Council and the custom of necessarily selecting the Vice-Chancellor from among the heads. For ourselves, however, we should greatly prefer to leave the emoluments and the university status of the heads unchanged, but to give the university a voice in their appointment. Among the headships are some of the few fairly well paid posts in Oxford, and it would be an immense gain to the university, and an even greater gain to the colleges, if it were generally understood that they should be filled by men for whom leisure and opportunity, and the release after long service from teaching, would mean more time spent and greater efforts made in the cause of learning.

The two Proctors, popularly supposed to be mainly concerned with the behaviour of undergraduates outside their college walls, are in reality the representatives of the M.A.'s, and in this capacity hold their *ex-officio* seats on Council as well as on nearly all the important boards of the university. Lord Curzon's proposal that they should serve for two years, and go out of office in rotation, would undoubtedly facilitate business, but is open to criticism for the following reason. The educating effect of a proctorship is remarkable. It is an important advantage that every year a member of the governing body of two colleges should learn by personal experience that the University of Oxford is something more than a name. The Proctors certainly do learn this lesson, and a man who has held the office, although only for one year, looks on his university with different eyes. We should seriously question the wisdom of reducing the number of those who receive so illuminating an experience. The principle of Lord Curzon's proposal would be carried into effect and its main advantages secured by rotation with a half-yearly period.

That Congregation should be restricted to those

M.A.'s who perform academic functions (Resolution ii., *b*) is, like many another desirable reform, merely a return to the original intention. It was proposed by Council a few months ago, but rejected by a small majority in Congregation. We may now hope and believe that with the support of the Chancellor and the renewed support of Council it will become an actual fact. The academic functions here suggested as qualifying for membership of Congregation are "teaching and administrative." Of course, all academic teaching to be valuable must be associated with research, and "teaching" was doubtless intended to be read in this sense; but in England it is unfortunately still premature to trust to the general acceptance of such an interpretation.

We do not touch on the tremendous and perhaps rather barren problem of the reform of Convocation. It is possible that, with greatly increased powers conferred on the Boards of Faculties, the consideration of this much disputed and very intricate question might advantageously be postponed.

The principle strongly advocated by the Chancellor and adopted in Resolution iii., *a*, "that Greek be no longer required as a necessary subject for a degree in Arts," was some years ago accepted by Council and successfully brought before Congregation, although the subsequent attempt to introduce a definite scheme was attended with failure. It is difficult to understand the feelings of those students of the noblest of all languages and all literatures in attaching so much value to the miserable and irritating minimum now required. It is sometimes said that the scientific student, requiring to propose new terms, would be benefited by possessing a knowledge of Greek, but it would be disastrous to the interests of language were he, with a hundredfold the experience, to make the attempt. The field is a very dangerous one, and full of pitfalls even for the most accomplished scholars. It is also said that the Englishman without Greek would find difficulty in understanding the meaning of numbers of English words. The answer is obvious. The moderate number of Greek words which are used over and over again in English should be taught as part of that most important, most neglected branch of a boy's education—his own language.

The principle of an entrance examination (iii., *b*) preliminary to matriculation would relieve the university from its present undignified position, compelled as it is to matriculate any and every student presented by a college.

The Chancellor's principle of a Board of Finance, accepted by Council in Resolution iv., is of the highest importance. Indeed, this principle alone may go far to secure the dominant influence of the university. It is to be presumed that the board will possess the power of preventing the waste of funds by unnecessary duplication of teaching no less than by unnecessary or extravagant buildings. Of equal importance is the cooperating principle accepted in Resolution v., "that some reconstitution of the faculties and boards of faculties should take place, with a view to the more systematic and economical organisation of university and college teaching." It is to be hoped that the reconstituted boards, with the addition of a Council of the Faculties, may relieve the Hebdomadal Council of the entire examination system, propose names for honorary degrees, advise the board of finance in the administration or control of the combined tuition fees, appoint all lecturers, and exercise advisory powers in the appointment of tutors.

Resolution vii., appointing a committee "to consider and confer with the colleges as to the emoluments and tenure of senior scholarships and of fellowships," is of almost equal importance to that of the two resolutions last touched upon. It is to be regretted that the whole system of prize-fellowships as instituted by the last commission, including the award by examination, was not condemned. It is sometimes said that it is such a good thing for politics, the Bar, and journalism that an able young man should be supported during the early barren years. No doubt it is a very good thing. Then let politics, the Bar, and journalism see to it. While there are capable students unable to pursue their researches in Oxford for the want of such funds, it is a scandalous abuse of academic endowment that they should be used in London to smooth the path to a professional career.

With regard to the following proposals made in resolutions of which the numbers are quoted, we need say no more on the present occasion than that they command our entire sympathy and approval:—The reconsideration of the scheme of college scholarships and exhibitions (vi.), an improvement in the executive machinery of the university (vii.), a better constitution of electoral boards to professorships (x.), and the provision, if possible, of a professorial pension scheme (xi.), a reconsideration of university and college fees (xiii.), and a discussion as to the possibility of reducing the expenses of living in college (xiv.)

There remains, however, one important reform which touches closely the dignity of the university. Oxford ought to regain its ancient long-lost power of admitting students, just as Berlin or Paris admits them, without compelling them to join any other body. If a senior American or Continental student now desires to work in Oxford under a professor, and to become for the time a member of the university, the authorities can only reply that he must first arrange to attach himself to a college or to the body of non-collegiate students. The situation is so strange to those accustomed to the ways of other universities that the student would probably in most cases be invited to work without joining the university, which thus loses the fees he is willing to pay and much of the distinction conferred by his researches. A proposal to admit such students to the university only just failed to pass Council a few years ago, and then only in consequence of opposition raised on behalf of the non-collegiate students. It is possible that the advantages of a collegiate title to express what has from the first been a reality would conciliate much of this opposition. It would be a wise policy to admit frankly that the non-collegiate body, in everything except residence within the walls of a college, possesses a collegiate structure, to adopt the name "St. Catherine's College," and to let the clumsy title "non-collegiate student" go the way of the older and even less desirable term "unattached." We might then reasonably hope that some benefactor interested in hard work and economical living at the university would be glad to erect a building where all the immense advantages of corporate life would be conferred on a large and deserving body of the poorer students. In such a college, if well managed, living ought to be considerably cheaper than in "licensed lodgings" in the city. In this way we believe that "the improvement of the position of non-collegiate students" sought by the Chancellor and by Council (in Resolution ix.) can best be brought about.

We have said enough to show how wide-reaching and remarkable, and, as we believe, beneficent, is the scheme of reform presented to Oxford University by the Chancellor. Not less remarkable is the effect it has already produced upon a seat of learning sometimes described, in old days perhaps correctly, but now with singular inaccuracy, as "sunk in port wine and prejudice."

SEVENTH INTERNATIONAL CONGRESS OF CHEMISTRY.

THE arrangements in connection with the seventh International Congress of Chemistry, which is to meet in London on May 27, are now practically completed. The series of meetings, which take place every third year, was originally started by a meeting of the Association of Sugar Chemists in Brussels. It was then extended to take in all branches of chemistry. Successive congresses have been held in Paris, Vienna, Paris again, Berlin, and Rome. With each successive meeting the popularity of the congress has increased, and it appears that this one will be not a whit behind those which have previously been held. There are seventeen sections and subsections, and a large number of contributions have been promised to each. The largest number of papers so far promised are for section ii., inorganic chemistry, and section x., electrochemical and physical chemistry. The growth of this latter section within the last few congresses is remarkable.

The amount of work and the number of papers to be got through in many of the sections will entail very careful organisation, and a very strong presidential hand to prevent prolixity. In section x. alone there are already about eighty papers promised, and the actual working time is eighteen and a half hours.

Beside the sectional work, there are to be four general lectures to the whole congress by Sir Boverton Redwood and by Profs. Haller, Paterno, and O. N. Witt. The first act of the congress will be a social one, when the Lord Mayor and Corporation will hold a reception at the Guildhall on Wednesday evening, May 26. On the next morning, at 10 o'clock, the joint organising committee will meet, and at 3 o'clock in the afternoon the inaugural meeting will take place at the Royal Albert Hall, when H.R.H. the Prince of Wales will formally open the congress. In the evening there will be a reception by the Foreign Office. On May 28 the various sections will start work in earnest, when they will be hard at it from 10 to 1.30; and at 2.30 Profs. Haller and Paterno will give their general lectures to the whole congress. In the evening there is to be a banquet at the Crystal Palace in the central transept. The Palace was taken because there is no other place in London sufficiently large to dine 2000 people, and it is hoped that at least this number will be present.

On Saturday morning the sections will meet from 10 to 2 o'clock, and in the afternoon there is to be a garden party at the Botanic Gardens, given by the ladies' committee. In the evening the hard-worked members of the congress will attend a reception given by the London section of the Society of Chemical Industry at the University of London. Sunday is to be devoted to private hospitality, as also is Monday evening. In this matter British hospitality is showing up well, as already the offers of private parties will absorb about 1500 members of the congress.

On Monday morning, May 31, the sectional meetings will take place from 10 to 1.30, and at 2.30 Prof. O. N. Witt will give a lecture to the whole congress, after which the sections will hold session from four to six.

The morning of Tuesday, June 1, is to be devoted to sectional work, and at 2.30 Sir Boverton Redwood will address the combined sections. Sectional meetings will then take place from 4 to 6. In the evening there is to be a reception at the Natural History Museum.

The official closing meeting of the congress is fixed for 10 o'clock on Wednesday, June 2, and in the afternoon the congress will visit Windsor Castle by permission of the King.

It should be mentioned that the annual meeting of the Society of Chemical Industry will commence on the morning of May 26; the presidential address will be delivered at 10.30, and a reception will be held at 4.30, so that those who are members of the Society of Chemical Industry and also of the International Congress will have a very severe week of work, both intellectual and social.

The meetings of the congress will be held in the buildings of the University of London at South Kensington, and at the Imperial College of Science and Technology, where the offices are located.

THE GOVERNMENT AND AËRONAUTICAL RESEARCH.

MR. ASQUITH'S announcement that a special Government Department for Aërial Investigation is being formed will be read with the keenest satisfaction by everyone who is interested in scientific research. It is but a short time ago that the Aërial League was founded under the chairmanship of Colonel Massy, mainly with the object of stimulating national interest in the aërial problem. The evidence before us points to the belief that, whatever other causes may have been at work, Colonel Massy's movement has been to the forefront among them. Of this we have abundant proofs in the fact that about the middle of April proposals of the League were discussed by a committee of the War Office appointed by Mr. Haldane.

An important feature of the movement is the appointment of a scientific committee to organise continuous researches, experimental and otherwise, on problems connected with the design and construction of aërial machines. The National Physical Laboratory at Teddington is to be the centre for these researches, and the committee consists of Lord Rayleigh (president), Dr. Glazebrook (chairman), Major-General Sir Charles Hadden, and Captain R. H. S. Bacon, representing the Army and Navy, Sir A. G. Greenhill and Prof. J. E. Petavel, Dr. W. N. Shaw, and Messrs. Horace Darwin, Mallock, and Lanchester. The Prime Minister has stated that special and adequate funds have been placed at the disposal of the committee, the War Office, and the Admiralty for carrying out the programme.

Regarding the working of the committee, nothing definite has as yet been announced. It seems, however, understood that in addition to experimental work, one of their functions will be to advise the Admiralty and War Office on inventions which may be submitted to them or on processes which it may be in the interests of the country for the Government to acquire instead of allowing them to be divulged.

It is clear, both from the constitution of the committee and from the accounts given in the Press, that mathematical and physical investigations are to receive a large share of attention, and that the mere building of aëroplanes and experience in manipulating them are not to interfere with the less enticing and no less important work of finding out the fundamental principles underlying their construction. The problem of stability is specially singled out for mention. The mathematics of this problem is pretty complicated, and it is easy to remain for a long time within clear sight of final conclusions when there is still much ground to be covered before reaching them. But, given the necessary methods of calculation, experiments are still required to determine the data involved in obtaining numerical results. A mathematical investigation now in progress tends to show that broad aëroplanes may be less stable than might be inferred from ordinary

calculations of their resultant thrust and centre of pressure. But such an investigation is necessarily based on hydrodynamical assumptions, and laboratory experiments are required before any practical use can be made of the conclusions. It must be remembered, on the other hand, that questions of stability or instability of particular types of machine can never be decided by flights in which the human element has a guiding influence. There is still work to be done with models. On the practical side the committee will have abundant experimental work in connection with propellers, for the motion of a screw in fluid presents complications which render any attempt at hydrodynamical treatment practically hopeless.

It is scarcely surprising that the cry "too much theory; fears that talk may injure work" finds its way into the papers, and that some members of the Aëro Club put in a plea for the "practical man." The fact seems, however, to be overlooked that the appointment of this committee forms only part of a general scheme, the practical side being provided by the War Office and the Admiralty, both of which departments have dirigibles in course of construction. A Parliamentary committee embracing politicians of all parties is also announced.

It would be more correct, however, to describe the present position of aëronautics in England as "too much theorising and too little theory." Many papers have found their way into aëronautical and other periodicals, some of them full of algebraic symbols and formulæ, but an investigation is not necessarily mathematical because it contains equations, and the author is not necessarily a mathematician because he employs them. Indeed, in many cases it is the "practical man" who revels in the excessive use and abuse of formulæ, and the mathematician and physicist who would like to bring themselves into touch with practical problems are consequently deterred from reading such literature. Moreover, there is a want of suitable journals for the publication of mathematical and physical investigations bearing on aëronautics. They would be rather out of place in physical journals which deal more with such subjects as electricity and radioactivity; while any writer bold enough to try the journals just mentioned would probably find himself involved in a controversial correspondence, and would learn that too much talk *did* injure work, especially as no good would probably come of his attempts to enlighten his correspondents.

The need is thus becoming imminent for a clear division of labour between the practical man and the physicist, and if such a division should do no more than make the practical man confine his attention more exclusively to experimental work, much would be gained, and his researches would be made more accessible and useful. A division of a similar kind has now, we are glad to learn, been arrived at between the three leading societies devoted to aëronautics, namely, the Aëronautical Society, the Aëro Club, and the Aërial League. The Aëronautical Society mainly exists for the purpose of promoting discussions on aëronautical matters, and these consequently fall within its province. The Aëro Club undertakes the development of aëronautics from the point of view of sport. It desires to encourage men of means and leisure to practise aviation and ballooning for the pleasure they derive, and with the incentive of competing for prizes. Finally, the Aërial League is to be the paramount body in influencing public opinion in the development of the subject from the point of view of national defence. An agreement to this effect has been drawn up and signed by the presidents of the several societies.

England's neglect of science has lost the chemical and optical industries, and in the automobile industry France had a long start of us. It certainly does appear evident that in regard to aëronautics at least a serious attempt is being made to recover lost ground in the field of international competition.

G. H. BRYAN.

DR. GERALD F. YEO, F.R.S.

THROUGH the death of Dr. Gerald F. Yeo, Emeritus professor of King's College, London, physiology has lost within a few weeks yet another of those men who, within the last thirty years, materially assisted in the creation of a British school of this science, which, though of late development compared with Continental schools, has grown with a rapidity and vigour equalled only by the advances made on the bacteriological side of pathology. In the foundation of the Physiological Society, which at first included hardly a score of members, Yeo took an active part, being its honorary secretary for fifteen years from 1874 to 1890.

Born in 1845, he was one of the sons of Henry Yeo, J.P., of Howth, received his education at the Dungannon School, then entered Trinity College, Dublin, and obtained his medical degrees in 1867. After some months of study in the hospitals of Paris, Berlin, and Vienna, he returned to Dublin, where he practised as a surgeon and taught anatomy until 1874. In this year he was elected assistant surgeon of King's College Hospital, and professor of physiology in King's College, the histological part of the work being undertaken by Groves During this time, until his resignation in 1890, Gerald Yeo, by his lectures, his research work, and, in particular, by his strenuous advocacy of the necessity of the experimental method in physiology, as the chief of those methods by which material advances in this science could alone be made, occupied a prominent and influential position. In 1885 he published a "Manual of Physiology," a book primarily addressed to students, which gave a concise account of the elements of this science. In the Arris and Gale lectures delivered at the Royal College of Surgeons in 1882 on "The relation of experimental physiology to practical medicine," Yeo has probably given all the essential arguments which have so repeatedly been urged by those who claim that the sure basis of physiological knowledge must rest upon experimental work. An excellent account of the systems of medicine not dependent upon physiology compared with the modern methods of rational treatment which depend upon physiological and pathological knowledge, together with a most accurate account of the growth of physiology, is to be found in these lectures. Among other points, Yeo emphasised the paramount influence of Haller, who, not only by his experimental work, but by a comprehensive survey of what was then known of physiology, may be said to have created this science, a science conceived in the days of Galen, quickened in the time of Harvey, but born only in the eighteenth century.

Gerald Yeo was elected a Fellow of the Royal Society in 1890. His original work covered a somewhat restricted field. In 1850 Helmholtz had measured the delayed time, or latent period, which precedes the actual contraction of muscle by the method of Pouillet. Instead of 0·01″ for frog's muscle, Yeo, in papers published by himself, and with Cash and Herroun, succeeded, with the pendulum myograph, in halving this value, which in its turn was finally found to be too long by Burdon-Sanderson, who, working with unweighted or slightly weighted muscles, obtained 0·04″ as the shortest time of delay,

which is not appreciably slower than the latent period of the current of action. Other papers published with Ferrier in 1881, on the functional association of motor fibres in the anterior roots of the brachial and sacral plexuses of the monkey, and in 1884, on cerebral localisation in the Philosophical Transactions, formed early and important contributions to those investigations on the functions of the central nervous system which have since been so extensively carried out by English physiologists. One of Yeo's researches, that on the gaseous metabolism of cardiac muscle, was of particular interest. He determined, by spectroscopic examination of the living heart and its fluid contents, the rate at which resting and active muscle utilised the oxygen of oxy-hæmoglobin.

At the time of the resignation of his professorship Yeo practically severed his connection with physiology, and his interest in this was largely replaced by the occupations of a country life. He was therefore but little known to younger men, who may not remember that much of the organised attack on the experimental methods of physiologists and pathologists was directed against work carried out by Yeo and others in his laboratory. Apart from his actual scientific work, he will be remembered by all who have the best interests of medicine at heart for his uncompromising attitude towards those who, either from ignorance or mistaken views of the ethics of the subject, strove to hinder, if not actually to prevent, physiological research in this country. G. A. B.

DR. BINDON BLOOD STONEY, F.R.S.

WITHIN a few weeks of his eighty-first year, Dr. Bindon Blood Stoney, F.R.S., died at Dublin on May 5. Dr. Stoney was born at Oakley Park, Birr, in 1828, and educated at Trinity College, Dublin, where he had a distinguished engineering course, graduating in 1850. His abilities were early perceived by the then Earl of Rosse, whom he assisted in the astronomical researches of the early 'fifties of last century. In 1852 he went to Spain, and was engaged on railway work in that country. On his return home he was engaged in the important work of the Boyne Viaduct, which was regarded as a remarkable engineering achievement at that time. It is, however, by reason of his work as engineer to the Dublin Port and Docks Board that Dr. Stoney will be most remembered. He was appointed assistant engineer to the board in 1856, and three years later chief engineer to the port, a position which he held until 1898. During his tenure of office, Dublin was converted from a purely tidal port into one in which some of the largest vessels may be moored alongside the quays and lie constantly afloat, and the river so deepened that the cross-channel steamers may enter and leave at all states of the tide. In this work Dr. Stoney used the method of laying down the harbour walls by means of large blocks of masonry, weighing as much as 350 tons, and sunk by means of shears on a prepared foundation, the quay walls of the Alexandra Basin, the North Quay extension, and other work being laid in this manner.

During the period of his association with the Port and Docks Board, Dr. Stoney was also engineer for the construction of the O'Connell Bridge and the building of the Butt Bridge, and the reconstruction of the Grattan Bridge over the River Liffey. Dr. Stoney was a Master of Arts and Master of Engineering of the Dublin University, and in 1881 the honorary degree of Doctor of Laws was conferred on him in recognition of his eminent position in the world of engineering. He was the author of "The Theory of Stresses and Strains," a standard book in its day, and of various papers in the transactions of scientific and engineering societies. He was president of the Institution of Civil Engineers of Ireland in 1871, and for many years a most active member of that body. He was elected a Fellow of the Royal Society in 1881, and in 1874 was awarded the Telford medal and premium of the Institution of Civil Engineers; he was also the recipient of many other honours. In addition to being a great engineer, Dr. Stoney was a man of wide and varied reading, and his judgment in letters and in art was of the soundest. His sterling worth and the value of his services to the City of Dublin will be long remembered.

NOTES.

THE secretary of the Royal Society made the following announcement at the meeting of the society on May 6:—Sir David Bruce, who is in charge of the Sleeping Sickness Commission at present in Uganda, cabled to the society on April 3 that the commission had confirmed Kleine's observations on the period during which the tsetse-fly was capable of transmitting a trypanosome infection. A letter was received on April 30 from Sir David Bruce, dated Mpumu Chagwe, Uganda, April 3, confirming the telegram, and stating that the commission had "repeated Dr. Kleine's experiments with *Trypanosoma gambiense* and *Glossina palpalis*, also with a trypanosome of the dimorphon type and the same tsetse-flies, and found the flies infective after sixteen, nineteen, and twenty-two days."

IT is well known that Lord Walsingham has long been an unwearied collector and student of the smaller moths, and that his collection of the Micro-lepidoptera is the best in the world, as he has not only added to it largely by his own efforts, having collected assiduously during his travels in various parts of Europe and North Africa, California, Jamaica, &c., but has taken the opportunity to purchase the most celebrated foreign collections, among others those formed by Zeller, Frey, Christoph, and Hofmann, as they successively came into the market. He has also contributed numerous papers on the subject to the Transactions of the Entomological Society, the *Entomologist's Monthly Magazine*, &c., and has also published several independent works, especially on the Tortrices and Pterophoridæ of North America. In 1891 this valuable collection was formally made over to the British Museum by deed of gift, Lord Walsingham arranging to retain it in his own hands as long as he desired to do so; but we now understand that it is his intention to transfer the collection to the care of the trustees of the British Museum (an office which he himself shares with others) in the course of next year.

DR. R. P. VERNEAU has been appointed to the professorship of anthropology in the Paris Museum of Natural History in succession to the late Prof. Hamy.

THE fifth Congrès préhistorique de France will be held at Beauvais on July 26–31. The general secretary of the congress is Dr. Baudouin, 21 rue Linné, Paris.

THE *Times* announces the death of Dr. John Thomson, of Brisbane, at the age of sixty-one. Dr. Thomson was a graduate of the University of Edinburgh, and settled in Brisbane more than thirty-three years ago, where he became recognised as an authority upon matters relating to sanitary science. He served as president of the Royal Society of Queensland, and was president of the Intercolonial Medical Congress in 1899.

MR. E. DE KOVEN LEFFINGWELL, the American explorer, is about to start from Seattle for a three years' expedition to northern Alaska. His main object is to map out the coast-line for a few hundred miles on either side of Flaxman Island, his winter quarters. As opportunity offers, he will also study the geological formations of the territory, and try to find out some large rivers in the interior of which the natives speak vaguely. His yawl, the *Argo*, will carry an auxiliary engine, besides sails, and its cargo will be limited to thirteen tons.

THE successful congress in connection with the suppression of frauds in food, which was inaugurated last year at Geneva, will be succeeded by a similar congress to be held in Paris during October of the present year. The principal object will be to define such methods as will prevent the fraudulent adulteration of food, but there will also be sections devoted to chemical products, pharmaceutical preparations, mineral waters, and similar substances. Further information as to the congress can be obtained from Mr. Loudon M. Douglas, College of Agriculture, Edinburgh. The general secretary is Mr. Robert Fazy, 42 Rue du Rhone, Geneva.

ON Tuesday next, May 18, Prof. J. Garstang will deliver a lecture at the Royal Institution on (1) "Monuments of Egypt and Asia Minor," being the first of a course of two lectures on "The Hittites," and on Saturday, May 22, Dr. W. H. R. Rivers, F.R.S., will begin a course of two lectures on "The Secret Societies of the Banks' Islands." The Friday evening discourse on May 21 will be delivered by the Hon. Ivor C. Guest, on "Afforestation," and on May 28 by Dr. Emerson Reynolds, F.R.S., on "Advances in our Knowledge of Silicon as an Organic Element." An extra Friday evening discourse will be delivered on June 18 by Mr. A. Henry Savage Landor, on "A Recent Visit to the Panama Canal."

THE many friends of the late Mr. Bennett H. Brough will be glad to know that the proposal to establish some permanent memorial to him has taken definite shape. Shortly after Mr. Brough's lamented death, a fund for his widow and children was started by the council of the Iron and Steel Institute, of which he was secretary, and the sum of about 6000*l.* was raised. There are, however, many old students of the Royal School of Mines, as well as others who came under the influence of Mr. Brough's inspiring personality, who, now the institute's fund is practically closed, desire to show their appreciation of his life and work by a lasting memorial. A committee has therefore been formed to raise a fund for this purpose, and has issued an appeal for subscriptions. It is suggested that the memorial should take the form of a scholarship for boys from the City of London School, where he was educated, tenable at the Royal School of Mines, where, both as student and teacher, he did such excellent work. Contributions should be sent to Mr. R. E. Commans, Speer Road, Thames Ditton, Surrey.

CONSIDERABLE changes are announced in the staff and administration of the London Zoological Gardens. For several months past a special committee has been investigating the state of affairs at the gardens, and the innovations, which are expected to lead to decided improvements in the well-being of the animals, are the results of the deliberations of that body. Dr. Chalmers Mitchell, the secretary, will continue to act as chief administrative officer in the gardens (where he will reside when the society's library and offices are transferred there), for the efficiency of which he alone is responsible to the council. As subordinates, he is eventually to have under him three curators, one each for mammals, birds, and reptiles. Mr. R. I. Pocock, who is to retain his present post of garden-superintendent, will have charge of the mammals, and temporarily of the reptiles, while Mr. D. Seth-Smith is to take over the custody of the birds, combining with this duty the office of inspector of works. Each curator is to have a head-keeper under him, and the aim of the council is that both curator and head-keeper should devote their whole attention and time to the care of the animals under their charge. If this work is properly done, the curators will have no time to spend on scientific zoology, as the care of the animals is quite enough to occupy their whole energies.

ON May 7 Lord Avebury presided at the annual conversazione of the Selborne Society. He alluded to the Bill to stop the destruction of rare and beautiful birds for the sake of their feathers, which the society, acting on the suggestion of Mr. Buckland and in conjunction with the Linnean Society, Zoological Society, and the Society for the Protection of Birds, introduced into the House of Lords last year. The House of Lords was very sympathetic, and passed the Bill, but the House of Commons could not spare time to consider it. This year, said Lord Avebury, Sir William Anson has introduced a similar measure, and he heartily wished it success. Mr. James Buckland afterwards exhibited a number of slides bearing on the destruction of egrets. The subject of flight was considered by Mr. F. W. Headley, of Haileybury, who showed by means of slides how birds fly, while Mr. T. W. K. Clarke followed with a lecture on how men fly, in which he contrasted the methods by which birds fly with mechanical flight, and showed by means of gliders how machines are automatically balanced. He also made a strong point of the fact that in the science of aëronautics Englishmen in the past led the way, and cited the names of Sir George Cayley, Henson, Stringfellow, and Wenham. As usual, there was a large series of interesting exhibits. The following attracted considerable attention:—a working exhibition showing the processes of the manufacture of microscope lenses, Messrs. W. Watson and Sons; an attachment for converting a tourist's telescope into an instrument for insect observation, Messrs. H. F. Angus and Co.; and a plan showing the position of the nesting-boxes and nests during the coming month in the Brent Valley Bird Sanctuary, Mrs. Wilfred Mark Webb.

AN influential deputation waited upon Mr. Runciman, president of the Board of Education, on May 6, to place before him the objections to the alleged intention of the Government to distribute what is known as the Indian Collection at the South Kensington Museum. Lord Curzon, in introducing the deputation, gave a historical summary of the nature and position of the collection. Briefly, the facts are as follows. Last year a departmental committee was appointed to draw up a comprehensive scheme for the re-arrangement of the products in the South Kensington Museum, in the interests, first, of people engaged in commercial production, and, secondly, for the due encouragement of art. The committee reported in favour of classification by material of all the contents of the Victoria and Albert Museum. This recommendation has provoked much opposition; and the object of the deputation was to urge that Indian art demands independent treatment, and that the ethnographical features of the present collection would be altogether sacrificed if the distribution according to subjects were carried out. The hope was expressed, therefore, that the Government

would not agree to the dispersion of the collection, and would consider favourably some scheme by which it would be given a permanent and suitable house as a whole. In his reply, Mr. Runciman did not commit himself to either proposition, though he said, "I do not wish to leave the present collection in the present bad building, and I do not intend to scatter it in the sense which was at first proposed." The whole matter is to be given full consideration again before any action is taken. The situation provides another instance of difficulties arising owing to the want of scientific system in the organisation and administration of our national museums, upon which we commented on April 29. Thirty years ago, the original collection was broken up, the geological and mineralogical products being sent to Jermyn Street, the vegetable products to Kew, some of the antiquities to the British Museum, and others to South Kensington. Now it is urged that this distribution was a mistake, and that all the collections should be brought together under one roof. We express no opinion upon these plans of aggregation and segregation, but we do say that if our national museums were controlled by men of knowledge and authority a definite and continuous policy would be the result, and the demand for re-consideration which now arises when any change is proposed would rarely arise.

To the May number of the *Century Illustrated Magazine* Mr. E. B. Bronson communicates an article on big game in East Africa, with special reference to the conditions and incidents attending lion-hunting and the pursuit of other dangerous animals. The author, who was for a year the guest of Mr. McMillan at Julia Farm, near Nairobi, from which he made excursions to the game-country, has had thirty years' experience of big-game shooting in America, and his views in regard to African sport of this nature accordingly possess a more than ordinary value and interest. Mr. Bronson was much struck with the extraordinary abundance of game on both sides of the railway between Voi and Nairobi, where the passengers are seldom out of sight of some kind of game-animals during the daytime. Special reference is made to the dangers connected with the pursuit of buffalo and rhinoceros, the author appearing to endorse the general opinion as to the excessive risks attendant on buffalo-shooting.

In the April number of *Das Blaubuch* Dr. T. Zell discusses the question whether animals take advantage of experience and become cleverer than their parents, the question being answered in the affirmative. Among numerous other instances mentioned by the author, reference may be made to the following. From early times it has been noticed that vultures have learnt to accompany armies in the field, for the sake of the prospective feast after a battle. Killer-whales accompany whaling-vessels, and gulls do the same. Crows in like manner learn to accompany the chamois-hunter as soon as they have seen the first victim fall to the rifle, and rough-legged buzzards follow the sportsman in pursuit of winged game. Birds and quadrupeds have learnt to take no notice of railway trains, as have horses of motors, and nowadays many fewer birds immolate themselves by flying against telegraph-wires than was formerly the case. Game animals of all kinds have learnt to know the range of modern rifles, while greyhounds have learnt to leave rabbits alone, just as foxhounds, if properly trained, take no notice of either hares or rabbits. Sheep-dogs, again, know by experience that it is only the members of their masters' flocks that it is their business to collect.

The sixty-seventh volume of the Journal of the Royal Agricultural Society, for 1908, opens with a portrait and biography of the late Sir Nigel Kingscote, and contains a number of papers on agricultural subjects and fruit-growing. Among these is one by Mr. H. Rigden on Sussex cattle, which are stated to be nearly allied to the Devon, but larger, bigger-boned, and more hardy in constitution, both breeds being probably derived from old medium-horned red cattle of the south and south-western counties. In colour, Sussex cattle, which are still mainly confined to the home counties, should be wholly red, with white tail-tufts, but white flecks may appear on the body, and the muzzles of the bulls must be white. A century and a half ago it was noted that Sussex cattle, like the pigs of the same county, were unusually long-legged, and it was suggested that this feature was due to the bad state of the roads. Be this as it may, when the Weald district was the centre of a great iron-producing industry the strong-limbed Sussex steers were specially well adapted for hauling timber through the heavy undrained tracks of the partially cleared forest. The Lyne herd, dispersed in 1903, were descended from the old working breed, and were probably the oldest in Sussex.

Dr. A. S. Hitchcock has prepared a catalogue, with analytical key, of the grasses of Cuba, that is published as the sixth part of vol. xii. of the Contributions from the United States National Herbarium. It is based largely on the specimens collected by Charles Wright, and named by Grisebach, Wright, and Sauvalle about 1870, and on recent collections made by members of the herbarium staff. There is a tendency to split the genera, as in the segregation of Syntherisma and Alloteropsis from Panicum. There is one genus of the tribe Bambuseæ, Arthrostylidium, with seven species. The new plants named by the author, which are enumerated in a separate list, include one new genus, Reimarochloa.

A forest pamphlet (No. 5) has been issued by the Government of India, in which Mr. A. L. McIntire deals with the production of "sal," *Shorea robusta*, in Bengal. Certain data are given for growth which indicate how greatly the figures vary according to the locality. In the Terai, saplings may grow 8 feet to 10 feet in as many years, but in dry districts the period would be thirty years or more. Natural reproduction from seed is difficult, as the seedlings are checked by faster growing species and creepers. A method of artificial reproduction consists in placing baskets of soil under seed-laden trees into which the seed falls and germinates; the baskets are then planted out where required.

In the latest number of the Journal of the Royal Horticultural Society (vol. xxxiv., part iii.) there will be found the proceedings of the conference held last October on the spraying of fruit trees. The four papers read at the conference contain a considerable amount of negative expression of opinion, but there are many useful suggestions regarding the composition and value of different fungicides and insecticides, more especially in Prof. Theobald's paper and the appendices giving the proportions for various washes. Mr. G. Massee generally advocated winter spraying to combat fungus diseases, while Prof. Theobald pointed out that, as a remedy against insects, spraying must be applied at a time when the insect can be reached by the wash. The efficacy of tobacco washes was generally conceded, the one drawback to them being the expense.

An important contribution to the cryptogamic flora of Leicestershire is made by Mr. A. R. Horwood in a paper

read before the Leicester Literary and Philosophical Society, and reprinted, with amplification, in the Transactions (vol. xiii., part i.). The author offers some general remarks on distribution, and provides a list of new records since the publication of the county flora in 1886 for all the crytogamic groups. Two well-marked regions are distinguished, the Charnwood Forest and the lowland region overlying Coal-measures, Keuper Marl, Lias Clay, or Sandstone. In these areas the chief plant associations are the calciphilous, the humus and peat dwellers, or oxylophytes, and the silicicolous. The lichens, liverworts, and mosses have been well worked, but there is opportunity for adding considerably to the records of fungi.

As a first step towards the preparation of a handbook on the trees of the Transvaal for the use of foresters, Mr. J. Burtt-Davy has compiled a preliminary catalogue of the native trees, that is published in the *Transvaal Agricultural Journal*. The species are catalogued according to their occurrence in four phytogeographical zones, the mist-belt, high-veld, middle-veld, and low-veld, and are also enumerated with vernacular names in systematic sequence. The mist-belt is the true forest region, and contains many species common to that part of the Transvaal and the eastern province of Cape Colony, such as the two species of Podocarpus, *Curtisia faginea*, *Olea laurifolia*, and others. The high-veld and middle-veld are steppe and savannah regions, but in the low-veld such important trees as the baobab, *Excoecaria africana*, *Afzelia quanzenis*, and *Copaifera mopane* are found.

WE have received the first part of the *Eugenics Review*, a new quarterly journal issued by the Eugenics Education Society (6 York Buildings, London, W.C.). In a short "foreword" by Mr. Francis Galton, it is explained that the review is not intended to rival the more technical publications of the Eugenics Laboratory, but rather to supplement them by demonstrating the bearing of eugenics on legislation and practical conduct; the review is consequently rather of a popular than a strictly scientific character, and the reader will hardly look for original contributions to knowledge in its pages. In the present issue Mr. Montague Crackanthorpe contributes an article on the eugenic field, the Rev. Dr. Inge an address on some moral aspects of eugenics, and Dr. Saleeby writes on the psychology of parenthood. Sir Edward Brabrook also deals briefly with the eugenic aspects of the Report of the Poor Law Commission. The address by Dr. Inge is of special interest as a thoughtful contribution to the subject with which it deals from a professor of divinity.

DR. J. J. DOBBIE, F.R.S., director of the Royal Scottish Museum, Edinburgh, in his report for 1908 gives a good account of the progress made in extending and re-arranging the important collections under his charge. In the archæological section the most valuable additions are the prehistoric Japanese collection of Dr. N. G. Munro, which is of the same type as that of Prof. Gowland, now in the British Museum, and a Babylonian clay tablet, which is believed to contain a missing portion of the Creation epic. Those of Dr. Felkin from the Upper Nile and of Dr. M. Pirie from the Burun country are interesting additions to the ethnographical series. The natural-history cabinets now contain the large collection of eggs of British birds made by Mr. O. A. J. Lee; a fine pair of Californian sea-elephants (*Macrorhinus angustirostris*), long supposed to be extinct, but lately re-discovered on the island of Guadalupe, some 200 miles off the coast of Lower California; and an example of the rare deep-sea oar-fish or ribbon-fish (*Regalecus glesne*), cast ashore at Dunbar. It is disquieting to learn that the safety of the collections is seriously endangered by the close proximity to the main building of two spirit stores, and it may be hoped that the Government will take early steps to acquire and demolish them.

UNDER the title of "The Romanichels, a Lucubration," Mr. Bob Skot issues privately through Messrs. R. McGee and Co., of Liverpool, a reprint of a lecture delivered before the Clevedon Naturalists' Association, in which he discusses the history, persecutions, character, and customs of the Gypsies. In this pamphlet he has brought together much curious information on this interesting people from sources not easily accessible, and he has reproduced, with the musical score, eleven characteristic Gypsy melodies, which were sung, probably for the first time before a learned society, during the delivery of this lecture. It is curious to find among the Gypsies survivals of the rule of concealed burial of the dead, streams, it is said, having been diverted, and the corpse buried in their beds, after which the water was allowed to resume its ordinary course. The writer attributes the custom, occasionally practised in this country at the present day, of burning the effects of deceased members of the tribe, not to the belief that these follow the dead man to the spirit world, but to the theory that the soul is so firmly attached to the body and its possessions that it cannot obtain freedom until these are destroyed. The custom of abstaining during life from the favourite food of a lost relation, and the belief that vessels are defiled by the touch of a dog's tongue or of a woman's skirt, suggest reminiscences of customs and taboos derived from the eastern home of the race.

PROF. G. MERCALLI has recently published a short account of the destructive Calabrian earthquake of October 23, 1907. The centre of the earthquake appears to have been near Ferruzzano, a small town on the east coast near Gerace. Here, 158 persons (or 8 per cent. of the inhabitants) were killed, and, immediately after the shock, the sea advanced inshore 30 metres, and then retreated. The district is one in which few earthquakes originate, but five preparatory shocks occurred in it, the first on the day after the earthquake of 1905, the last three minutes before the principal earthquake. Though the ground was fissured in places, there were no faults; there was no marked shifting of railway-lines, and no permanent displacement of the earth's crust. The number of after-shocks was small. Prof. Mercalli attributes the excessive damage at Ferruzzano to its erection on an isolated eminence and on a slope, and to the friable nature of the ground on which the houses were built.

THE Publications of the Iowa Geological Survey are usually devoted to economic subjects, but the eighteenth volume, just received, consists chiefly of a memoir of general scientific interest. This work, by Dr. Charles R. Eastman, of Harvard University, is entitled "Devonian Fishes of Iowa"; but it is, in fact, a discussion of the Lower Palæozoic fishes in general, with special reference to those found in North America. It is a critical summary of the subject, with many quotations from the latest memoirs, and a brief statement of Dr. Eastman's own opinions, which have already been published in scattered papers. The Devonian rocks of Iowa itself have yielded only fragmentary fish-remains, but one quarry in the upper beds has furnished an astonishing number of the teeth of Chimæroids and Dipnoans, which exhibit much variety. Dr. Eastman thinks that, when well-preserved skeletons are found, the Devonian Chimæroid fishes will prove to have been armoured with thin dermal plates and with

dorsal fin-spines. The most interesting discovery recorded is that of a new palæoniscid fish, *Rhadinichthys deani*, from the uppermost Devonian shales of Kentucky. It occurs in phosphatic nodules, and the state of preservation is such that even the brain and organ of hearing can be examined and described. According both to Dr. Eastman and to Dr. G. H. Parker, the brain, semi-circular canals with ampullæ, and even some of the blood-vessels, are actually phosphatised, and can be perfectly exposed by cutting away the investing bone. Dr. Parker adds a detailed description of these parts, showing that they differ in no respects from those of a typical modern bony fish, but the accompanying illustrations from photographs are unfortunately not satisfactory. Dr. Eastman concludes his memoir with a useful list of the Devonian fishes hitherto discovered in North America.

WE have received from the Meteorological Office charts referring to the meteorology of the North Atlantic and Indian Oceans, and from the Deutsche Seewarte similar charts for the North Atlantic, for the months of April and May, 1909, which are, as usual, replete with mean statistical and current information useful to seamen. In addition to data relating to normal conditions of winds, currents, &c., both institutions give special charts of fog and mist in the North Atlantic. During the warm season, from April to August, fog is a source of great danger to navigation, especially on the eastern part of the Newfoundland Bank, owing to marked differences of temperature between sea and air, and this danger is increased by the southern drift of icebergs across the sailing routes. From a useful report on the state of the ice in the Arctic seas in 1908, recently issued by the Danish Meteorological Institute, the opinion is expressed that there will be no abnormal risk from ice in 1909 either along the south-west of Greenland or near Newfoundland.

TO the *Cairo Scientific Journal* for January last Mr. B. F. E. Keeling communicates an interesting paper on climate changes in Egypt. There is a strong belief amongst residents that changes have occurred within the last ten or twenty years (possibly due to increased irrigation) which are distinctly "sensible," without the aid of instruments. Mr. Keeling quotes the mean temperature at Abbassia for each pentade from 1870–1904, and for the four years 1905–8; but the results show that the differences are hardly greater than might be caused by difference of exposure of the thermometers. As regards humidity, also, there is very little evidence of any decided change during the last forty years. It is confidently asserted by many persons that the rainfall has increased during quite recent years, but the author shows that there is little, if any, evidence of such being the case. The total rainfall of any year is often influenced by the fall on a single day, and is consequently very variable from one year to another; the driest year on record at Abbassia is 1892, with little more than a quarter of an inch of rain, and the wettest, 1904, with less than 3 inches, the mean for 1887–1908 being approximately 1·4 inches.

IN No. 1, vol. i. (second series), of the Proceedings of the Tokyo Mathematico-physical Society, Mr. H. Nagaoka publishes the results of a recent research on the complex structure of some of the lines in the spectrum of mercury. The experiments were made with a 35-plate echelon spectroscope made by Hilger, and having a resolving power of 430,000 for light of wave-length 5000 Ångström units. The lines at λ 5790, λ 5769, and λ 5461 were analysed, and Mr. Nagaoka finds several companions in each case which were not recorded by Janicki, Galitzin, Stansfield, or Baeyer. A remarkable feature of the companions of the green line (λ 5461) is the symmetrical arrangement of certain pairs of them about the principal line, and an apparent constancy of wave-length difference between consecutive lines. Further research will be necessary to establish these features as objective realities, a point which is not overlooked by the author, who discusses at length the possibility of certain lines being illusory, optical phenomena.

THE origin of the colours of the spectrum forms the subject of an article, by Prof. P. Zeeman, in the *Rivista di Scienza*, v., 9. The first part is mainly philosophical in character, and deals with the question whether white light is really a mixture of rays of different wave-lengths or a mere succession of impulses, the phenomena of colour in the latter case being due to the action of the spectroscope. The second part contains a summary of recent results relating to magnetic action on light. Some recent experiments on the shifting of the middle line of a triplet are described by Prof. Zeeman in the Proceedings of the Amsterdam Academy, published January 27. In the *Archives Néerlandaises* (2), xiii., p. 260, Prof. Zeeman discusses the following questions:—applications of the decomposition of rays to the measurement of the intensity of magnetic fields; relation between the intensities of the components of a triplet; the dissymmetry in intense fields; observations by Fabry and Pérot's methods; determination of the charge on electrons; observations in the direction of lines of force; and dissymmetry of the triplets in the spectrum of tungsten. A note on Halé's observations of the magnetic decomposition of the lines of the spectra in sun-spots appeared in the *Physikalische Zeitschrift*, ix., 23, pp. 834, 835.

A SIMPLE method of finding indices of refraction of liquids under the microscope is described by Dr. Enrico Clerici in the *Atti dei Lincei*, xviii., 7. In its simplest form it consists of a glass slip with a thick cell, and a triangular glass prism cemented on it. A line ruled on the under side of the prism is brought into collimation with a wire in the focal plane of the eye-piece, and when the cell is filled with any liquid the apparent displacement of the line determines the index of refraction.

ON September 21, 1908, Dr. Hermann Minkowski read a paper before the German Naturalists' and Medical Association at Cologne on "Space and Time." It was his intention to develop the ideas into a more complete theory of mechanics, in which time would appear to be regarded as a fourth dimension coordinated with the three dimensions of space. Unfortunately, Minkowski did not live to realise his project, his life coming to a premature end on January 12. In accordance with a wish expressed by him, "Space and Time" has now been printed by the Teubner Press, of Leipzig, with a preface by Prof. Gutzmer, of Halle, and a portrait of Minkowski. It is an interesting memorial of the author, and the printing and general get-up are of the best.

DESIGNERS of posts and brackets for electric street lighting will be interested in two well illustrated articles on these fittings in the April number of the *Illuminating Engineer* of New York. Although many of the posts figured are most elegant in design, there is obviously a tendency in America to introduce Corinthian columns more appropriate for supporting substantial buildings than arc or incandescent lamps.

La Nature for April 24 contains an account of the experiments and measurements which have been made to discover what was the cause of the notoriously bad acoustical properties of the large hall of the Trocadéro at Paris. The work has led to several valuable conclusions as to the effect of a sound reaching the ear by two paths which differ in length by various amounts up to 34 metres. One of these is embodied in the statement that, for good audition, surfaces far from the audience must be absorbent, while surfaces near them must be reflecting.

IT will be remembered that two years ago the well-known "pleochroic haloes" observed in rock sections were shown to be due to the radio-activity of the inclusion round which the halo occurs. The point was brought out about the same time by Prof. O. Mügge in Germany and by Prof. Joly in this country. The former author now contributes further observations on the action of radium in producing these effects on a variety of minerals. His results will be found in the *Centralblatt für Mineralogie* (1909, p. 65).

MR. C. BAKER, of 244 High Holborn, W.C., has submitted to us two microscope objectives of a new formula which he has recently placed on the market. They are (1) a one-sixth inch numerical aperture, 0·75; (2) a one-twelfth inch numerical aperture, 1·30. The former has approximately a working distance of one millimetre, which for its focal length is considerable, and is intended for use with thicker cover glasses or with a hæmocytometer. The one-twelfth inch objective is particularly suited for bacteriological work, and, considering that it has a large field, its definition is excellent. We have tried these lenses both visually and photographically, and can find little fault with them. They are of the type that most English makers have recently introduced, and are intended to meet the need for cheap lenses for students' purposes and for ordinary use in the commercial applications of the microscope. The prices of these lenses are thirty shillings and five pounds respectively, and it is somewhat reassuring to find that English firms are making a determined effort to meet the severe Continental competition in the cheaper class of microscope apparatus, by introducing lenses of such a high order for so reasonable a price. Photographically, both these lenses are most satisfactory, and, if used in conjunction with a light yellow screen which cuts out the blue-violet portion of the spectrum, the results to be obtained with them are excellent. In common with most lenses of this type, their focal length is slightly shorter than marked, but this but little detracts from their performance.

THE new White Star liner *Laurentic* left on her first voyage to Canada on April 29. The performance of this vessel, built by Messrs. Harland and Wolff, of Belfast, will be looked for with interest, as she is the first Atlantic liner to be fitted with a combination of reciprocating and turbine machinery. Meanwhile, we note from an article in *Engineering* of April 30 that the vessel has a length of 565 feet 6 inches over all, beam 67 feet 3 inches, and depth, moulded, 45 feet 6 inches; the displacement at service draught is about 20,000 tons. The idea of the combination of machinery is to utilise in the turbine the remaining heat energy in the exhaust steam from reciprocating engines, which is generally at a pressure not less than 10 lb. per square inch absolute. The Parsons steam turbine enables such steam to be expanded economically to a very low absolute pressure. In the *Laurentic* the reciprocating engines are of the triple-expansion type, with four cylinders to ensure perfect balancing. There are twin reciprocating sets, the low-pressure Parsons turbine being placed in the centre of the ship and abaft the main engines, giving three propeller shafts. Arrangements are provided for throwing the turbine out of action for all manœuvring, the reciprocating engines then passing their exhaust steam direct to the condenser. The experience derived from this vessel should be of service in proportioning the machinery of the two 45,000-ton White Star liners now being built in Belfast.

OUR ASTRONOMICAL COLUMN.

MERCURY AS AN EVENING STAR.—In the comparatively clear evening skies of the past week, the planet Mercury has not been difficult to locate when one knew the direction in which to look for it. At present it is in the constellation Taurus, to the south-west of β Tauri, and sets about two hours after sunset.

The greatest eastern elongation takes place on May 20, but the planet is better seen some days before, rather than after, an elongation occurring in the spring. At 8.30 p.m. on Saturday last, May 8, it was easily found with opera-glasses whilst some four or five degrees from the horizon, and then watched for some time with the naked eye.

THE PRESENT SOLAR ACTIVITY.—A large group of spots was seen coming round the eastern limb of the sun on Friday last, May 7, and was in full view on Saturday, when it was seen to consist of two moderately large spots with several smaller ones, and to cover a fairly extensive area. On Sunday the group was visible to the naked eye, shielded by a piece of smoked glass, whilst with a pair of opera-glasses (×3), similarly shielded, it was quite a prominent object.

Spectroscopic observations made at the Solar Physics Observatory by Mr. W. E. Rolston on Saturday showed that the dark D_3 (helium) line was to be seen quite marked in the different inter-umbral areas and beyond the group.

THE INTRA-MERCURIAL PLANET PROBLEM.—As reported in our discussion of the results obtained by the Lick-Crocker eclipse expedition to Flint Island (NATURE, No. 2038, vol. lxxix., p. 70, November 19, 1908), Prof. Campbell considers that the negative results obtained at successive eclipses in the search for a possible intra-Mercurial planet demonstrate that no such planet exists as would account for the anomalies in the motion of Mercury.

In the May number of the *Popular Science Monthly* (vol. lxxiv., No. 5, p. 494) he now gives a most interesting popular account of the search for the hypothetical planet, and the means whereby its existence has been disproved.

In closing this account, Prof. Campbell refers favourably to Prof. Seeliger's recently published conclusions that the Mercury anomalies may be accounted for by the action of the material which gives rise to the zodiacal light, and shows that the figures calculated by Seeliger agree, within the probable errors, with the observed values, as reduced by Newcomb, of the perturbations of Mercury, Venus, the earth, and Mars.

The Lick Observatory search is fully discussed, in Bulletin No. 152, by Dr. Perrine, who points out that, whilst small bodies may yet be discovered near the sun, the eclipse plates show that no planet of the eighth magnitude was photographed. Such a planet would hardly exceed twenty or thirty miles in diameter, and it would require about a million such bodies to account for the outstanding Mercury perturbations.

PARTIAL ECLIPSE OF THE SUN IN CANADA.—From Dr. Downing we have received particulars of the partial phase of the solar eclipse of June 17 as visible at the Canadian observatories. At Ottawa the greatest phase (0·601) will occur at 7h. 43m. (standard time, 5h. W.), and the sun will set partially eclipsed at 7h. 50m.; first contact will occur at 6h. 52m. At Toronto the times will be:—first contact, 6h. 57m.; greatest phase (0·540), 7h. 48m.; sunset, 8h. 0m. In each case the sun's altitude at first contact will be approximately 9°.

SPECTROSCOPIC BINARIES.—A number of newly discovered spectroscopic binaries are discussed briefly in No. 3, vol. xxix., of the *Astrophysical Journal*. Prof. Campbell reports that, in the course of the regular observing programme with the Mills spectrograph, the following eleven stars have been shown to have variable radial velocities :— γ Persei, ξ Tauri, θ^2 Tauri, l (53) Eridani, ζ Aurigæ, ρ Orionis, β Canis Majoris, ν Draconis, 70 Ophiuchi, 111 Herculis, and ϕ Cygni. Of these, γ Persei and l Eridani probably have long, whilst θ^2 Tauri and β Canis Majoris probably have short, periods, and 70 Ophiuchi is a well-known double star with a period of eighty-eight years.

As the result of the recent investigations of the D. O. Mills expedition to Santiago, Chile, Dr. Heber D. Curtis announces that five stars, ζ Canis Majoris, τ Puppis, o Velorum, d Carinæ, and q Velorum, have been shown to be spectroscopic binaries, the first four probably having long periods. Two other stars, ν Puppis and ν Octantis, also photographed at Santiago, are announced by Prof. W. H. Wright as spectroscopic binaries.

HARVARD COLLEGE OBSERVATORY.—Prof. Pickering's report of the work performed at the Harvard College Observatory during the year ending September 30, 1908, directs special attention to the large amount of publication during that period. With the help of a monetary grant from Mr. Fairchild, no fewer than six volumes of annals have been completed, the publications of the twelve months exceeding in amount those of the first thirty years of the observatory's existence. Fourteen thousand settings with the polarising photometer related chiefly to variables of the Algol type, and will serve to determine their light-curves and epochs of minima. About thirteen hundred settings on the asteroids Iris and Eros showed that at present their light does not vary. Four thousand one hundred stellar photographs were taken at Cambridge and 3509 at Arequipa during the year, and numerous nebulæ, stars with peculiar spectra, six meteor trails, and many variable stars were thus discovered.

THE PERCY SLADEN TRUST EXPEDITION TO THE INDIAN OCEAN.

FINAL EXPLORATIONS.[1]

THE field work of the above expedition has now been completed with the return of Messrs. H. Scott and J. C. F. Fryer from the Seychelles and Aldabra on March 29. Mr. Scott has brought with him more than 40,000 insects from the Seychelles as a result of eight months' collecting. Among these are many remarkable forms, including a very large number of beetles, which will take some years to determine. The tropical rains of December and January brought out a great variety of insects not previously obtained.

Mr. Fryer spent nearly five months in Aldabra. His preliminary report, which is subjoined, is of great interest as showing the foundations on which that so-called atoll is built. Aldabra contains about fifty square miles of land, and was supposed to be a typical atoll, almost completely land-locked. It was also known for its still containing numerous gigantic land-tortoises, and for its partially peculiar avifauna. Some sand from it, which I obtained in 1905 in Seychelles, showed the presence of a considerable quantity of silica, on account of which we deemed its exploration necessary.

Mr. R. H. Rastall, who has examined some fragments of the Aldabra rocks, forwarded to me by post, writes that "they promise to be of very great petrological interest, as they consist for the most part of spherulitic and devitrified volcanic glasses."

J. STANLEY GARDINER.

I arrived in Aldabra at the end of the south-east monsoon. Owing to the extreme dryness of the season I decided to explore the island at once with regard to its geological formation, leaving its zoology and botany until the wet season.

I had four camps, *i.e.* on Michel Island, at Takamaka on Main Island, on Esprit Island, and on Picard Island, from which I examined every portion of the so-called atoll. Owing to the dense and almost impenetrable scrub there were always great difficulties, as I had everywhere to cut paths; in addition, I cleared several broad sections from the sea to the lagoon in order to get a clear idea of the sequence of the rocks and vegetation and of the relative elevations.

The nature of the ground and of its vegetation is such that the land may be divided into four somewhat irregular zones, from the lagoon outwards, as follows :—

(1) Mangrove swamp—varying in size up to nearly a mile in maximum breadth.

(2) Champignon—the surface much metamorphosed, highly crystalline, coral rock, usually with sharply defined dark portions, in which the crystals appear to be imbedded in a brown amorphous substance. It has evidently been subjected to heavy rain denudation, its surface being a mass of points and pits. The vegetation is a scrub of *Pemphis acidula*.

(3) Platin—fairly smooth, composed mainly of coral fragments and reef débris with a few shells, weathering into large flat slabs with soil accumulating in the crevices. In places are larger depressions, in which there are usually clumps of trees. The soil is guano, with a mixture of disintegrated rock. The vegetation is varied, containing numerous small bushes and trees, Pandanus, Ficus, Euphorbia, &c.; the fauna is also varied, and comparatively rich.

(4) Shore zone—largely of blown sand, with a stunted and wind-swept vegetation; large clumps of Pandanus, Tournefortia, and Scævola everywhere very numerous.

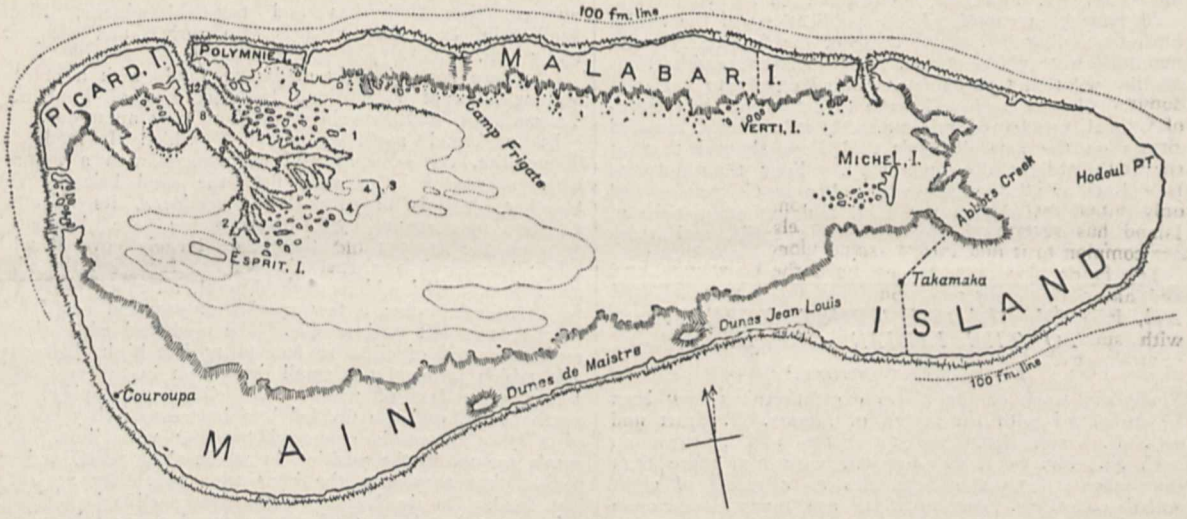
In a broad sectional clearing which I made at Takamaka, the seaward reef commences with a fissured edge, succeeded by a sand flat, the sand being bound together by beds of grass-like Cymodocea, its rhizomes greatly overgrown by Lithothamnia; the buttresses between the fissures are themselves largely covered with sand; live coral is almost absent; not far from the edge are a few small boulders of dead coral, all much encrusted with Lithothamnia; a few species of seaweed are found in the pools left at low tide. The landward edge of the reef is formed of cliffs 12 feet to 15 feet high, just outside which is usually a small depression in the reef with 2 feet or 3 feet of water. The cliffs are sloping, not overhanging, and are divided into buttresses; they consist of a mass of corals cemented together with lime. The corals are all in the position in which they grew, and so perfect that they give the impression that they are only just dead. On the landward side of the cliffs is a ridge, 2 feet or 3 feet higher, of grass-covered sand; this marks the seaward edge of the shore zone, which is about 250 yards wide, the sand being shallow and lying on a basis of coral rock. Then comes a ridge, 4 feet to 6 feet higher, the rock more solid and less denuded; this, the highest part of the section, is some 25 feet above sea-level. From the landward side of this ridge the level gradually decreases to about 10 feet above sea-level. It passes into a zone of Champignon, which here lies outside the Platin zone, which latter extends to the mangrove swamp. The Platin is all very similar in appearance, except that it is more wooded near the lagoon; it terminates with a sharp drop through the last 4 feet or 5 feet to the lagoon surface. At Takamaka there is a spring of fresh water and a grove of large Calophyllum and Ficus trees. This spring, with three others all lying between Takamaka and the lagoon, is the only constant source of fresh water on the islands. The section finishes at Abbot's Creek, which is a narrow passage from the lagoon with a thick undergrowth of mangroves on each side; its bed is rocky, and covered with very fine white mud; at its termination in the land it passes between small cliffs, all much overhung and obviously breaking down.

In another section, which passes from Vert Island in the lagoon northward to the sea, the country is all, with the exception of the shore zone, of the Champignon type, Platin being entirely absent. There is a gradual slope from the lagoon, becoming steeper at the beginning of the shore zone; right up to the latter salt water is often

[1] For earlier reports see NATURE, April 13, August 10, October 5, November 9, December 21, 1905, January 25, 1906, and December 17, 1908.

found in pits in the rock, fluctuating, apparently, with the lagoon tides. The cliffs on this north coast are 4 feet or 5 feet higher than those before described, and are always much overhanging. Caves penetrate far into their faces, large portions of which have at intervals fallen on to the reef; this fallen rock appears to become disintegrated quickly, as small pieces are uncommon, the action of the sea being assisted by boring animals (small Gephyreans, boring molluscs, &c.). As elsewhere round the coast, the rock shows its component corals in a way which leaves no doubt as to their being absolutely in the same position as previous to their elevation. On the reef here there are three or four distinct regions; close to the cliff there is a small belt of bare rock, often worn into hollows containing 3 feet or 4 feet of water; then a large area, mainly of broken coral fragments covered with Lithothamnia, and edged outside with a small boulder zone; and outside this, again, buttresses with a few colonies of living corals in the channels. Such are the usual features of the fringing reef at Aldabra, the appearance in the Takamaka section being quite exceptional.

After the previous descriptions it is possible to speak more generally of Aldabra. The cliffs, as stated, show their structure wonderfully clearly; except in the Southern Bight, where they are sloping and buttressed, they are much overhung, and are crumbling fast. The general



The Aldabra Group. Scale, about 3½ miles to 1 inch.

variations in level across the land are similar; the highest point is near the sea, and there is a steady decrease in level to the lagoon.

As regards the nature of the land, all the northern portion of the atoll—Polymnie Island, Malabar Island, and the north-east part of Main Island—consists of Champignon. The south-east portion of Main Island is chiefly Platin. In the centre of the south of Main Island there is a wide shore zone, and then a belt of Champignon. To the east and west of this portion are large mounds (65 feet in height) near the shore. They are obviously wind dunes, the seaward slope being gradual with little vegetation, the landward very steep and covered with bush. Opposite each dune the cliffs have almost entirely vanished, a direct slope of sand leading up to the dune. It is noticeable that in Aldabra, as in the other islands of this part of the ocean, dunes are only formed on the coast facing the strong south-east trades. The west portion of Main Island is chiefly Champignon. At Couroupa there is a dip in the rock which appears to extend from the shore right across to the mangrove swamp; it is filled with sand, and attains a maximum depth of 8 feet.

There are two islands now left which are of peculiar importance, *i.e.* Esprit and Picard. Round the south and west of Esprit there is a ridge of rock about 30 feet high, which has been worn away in places so as to make clear its section. The ridge itself is formed mainly of a sort of brown conglomerate or pudding stone, which in one place is capped by a chalky deposit, in which there is a certain amount of flinty rock. On the south side, towards the east end of the ridge, are some large masses of dark-brown rock at sea-level. The greater part of the body of the ridge is formed of the conglomerate, but this darker rock seems to enter more into its composition at lower levels. On the sides of the ridge are pinnacles of a rough and pointed rock, which is apparently a calcareous deposit, perhaps a mollusc bed, as it is largely formed by shells. The pinnacles are only a few feet high on the outer side of the ridge, but towards the centre of the island form a series of grotesque, upstanding pillars and walls, varying up to 15 feet in height, and standing on brown conglomerate rock.

Picard Island is mainly of the typical coral-rock structure. To the south-west there is a plain of Platin country, on the east side of which is a large basin in subterranean connection with the lagoon. On the floor of this basin I found several small lumps of dark brown rock, apparently the same as on Esprit, and on its north side there is a certain amount of the same conglomerate, though the main portion of the rock is apparently calcareous; much of it is highly crystalline calcite. Some extraordinary pieces of rock were found, apparently a calcareous matrix thinly enamelled with a transparent brown substance. Bones, the teeth of sharks and rays, and the remains of other organisms at present unidentified, were numerous in the calcareous rock, and also in a rock which appears to be conglomerate of a fine texture. As at Esprit, there is also a considerable quantity of the pinnacled shell rock.

It is, of course, quite unnecessary to emphasise the interest of the above formations. It appeared to me that the whole must have been volcanic in origin, and it is to be hoped that the examination of the rocks from Esprit and Picard may furnish a clue as to the nature of the base on which Aldabra is built.

The four Passes into the lagoon are also interesting, and perhaps give a clue to its formation. They have usually deep central channels, with reefs on either side. Small rock islets are present on these reefs, and it appears certain from their existence that the Passes are steadily increasing in size, and that their reefs are really the remains of the land kept up to low-tide level by growing coral. Live coral extends for some distance into the lagoon, there being in all cases a luxuriant bed just inside the Pass. At the mouth of the Pass all corals are largely encrusted with Lithothamnia, and further seawards many are completely killed by these algæ.

Besides the existing Passes, it should be noted that there seems a likelihood of at least three more being formed —at Camp Frigate the mangrove swamp extends right through the island to the sea, and no doubt a certain amount of water already traverses the land at that point; in Polymnie Island, at one place the swamp is within 100 yards of the shore, and a Pass will probably be formed in time; at Dune Jean Louis there is only a quarter of a mile between the sea and the swamp, and if the lagoon erosion continues no doubt Main Island will be divided at this point. It is worthy of note that fresh Passes seem always to be formed by lagoon erosion, and not from the seaward side.

The lagoon itself is very shallow, and the bottom sandy in the middle, changing into fine mud as one approaches the mangrove swamp. Everywhere one is forcibly struck by the extent of the erosion in the lagoon. Judging by its maze of small islands and mushroom-shaped rocks, at least one-third, or even more, of the lagoon can be shown to have been land at one time. At spring tides the amount of fine mud carried out to sea in suspension is very large, and it is obvious that the lagoon is still growing in size. There is some difficulty in accounting for the rapid transformation of the rock into mud, as boring animals are not common; I would suggest that possibly the mangroves have some further action on the rock than merely helping to split off large pieces.

As regards the vegetation, it is impossible to say much until the specimens collected have been worked out. The mangrove swamps extend right round the lagoon sides of the islands, Rhizophora and Brugiera being the predominating genera, though there is also a large quantity of Ceriops. Rhizophora seems to require a deep mud, but Brugiera thrives better in the more rocky places and on the small islands. In the extreme east of the atoll there is a large forest of the pseudo-mangrove Avicennia. The only other fact that need be mentioned is that Esprit Island has several plants not found elsewhere, or which are common to it and Picard Island alone.

The fauna also must be left until the collections arrive and have been examined. So far as can be seen at present, it appears to be of the regular coral-island type, with such additions in the land animals as would be natural considering the large amount of land and the larger flora. It should, however, be remarked that the mangrove swamps were very disappointing in their fauna, a condition very different from that described in mangrove swamps in other localities.

Large numbers of giant land-tortoises still exist, but the problem of their distribution does not relate to Aldabra alone, as I have found their remains on Assumption and Cosmoledo, and they are also known to have occurred in nearly all the Seychelles islands, two of which, Bird and Dennis, are coralline in structure.

In conclusion, I would suggest that the reefs and islands of the Aldabra-Farquhar line present a most interesting series in the possible life of an atoll.

(*a*) *Astove.*—Land rim of atoll almost perfect, and mostly rocky. Only one small Pass of recent date. Lagoon exceedingly shallow, but getting rapidly deeper. Formation of another Pass proceeding.

(*b*) *Aldabra.*—Land rim still very perfect, and mostly rocky. Several Passes already in existence. Strong evidence of increase of lagoon at expense of land. Lagoon deeper, and at least three Passes in course of formation.

(*c*) *Cosmoledo.*—Land rim broken up into a series of small islands only. Most of encircling reef bare, but evidence of a former rock-cap in mushroom-shaped rocks and minute islands. A noticeable increase of sand on the island, and decrease of rock. Lagoon deeper than that of Aldabra, and more open.

(*d*) *Farquhar.*—Judging from your description,[1] land rim very small. Island nearly all sand, and typical coral rock very scarce. Lagoon still more open.

(*e*) A final or hypothetical stage may be imagined as an atoll with a considerable lagoon, without, perhaps, any land, or, if land is present, only as sand cays piled up on the reef.

J. C. F. FRYER.

[1] Stanley Gardiner. Trans. Linn. Soc., xii., pp. 140–5.

ROAD MOTORS AND PROBLEMS CONNECTED WITH THEM.

THE "James Forrest" lecture was delivered at an extra meeting of the Institution of Civil Engineers on April 26 by Colonel H. C. L. Holden, R.A., F.R.S. The author took for his subject the road motors of the present day, and some unsolved problems connected with them. The modern era of mechanically propelled road vehicles was inaugurated with the passing of the Act of 1896. In the case of steam traction engines there has since then been no rapid progress; problems awaiting solution in this class are (*a*) greater economy of fuel; (*b*) means of condensing all or part of the water converted into steam; (*c*) reduction of weight and increase of adhesion surface to the road with minimum pressure per unit area on the road, without sacrifice of other qualities, including speed.

The problems regarding medium and light road motors are similar, and the author devoted most of the paper to the latter type, which includes passenger vehicles, light delivery vans, and motor-bicycles, tricycles, &c., the speed of which is limited by law to twenty miles per hour. Though by far the greater number of such vehicles are driven by petrol engines, there are others driven by steam, electricity, and combined systems; compressed air and liquid air have also been tried, but have never passed the experimental stage. It is estimated that, of the 100,000 motor-cars and cycles in use in the British Isles, more than 99 per cent. are driven by petrol engines. In spite of the great inherent advantages of the steam engine, steam-driven road motors form so small a proportion of the whole as to render it obvious that at present their advantages do not outweigh their disadvantages. For heavier goods and public passenger vehicles they may in time compete with petrol vehicles, but for private motor-cars the boiler and burner will always, in the author's opinion, handicap the system's other advantages. Electric propulsion would be ideal if a source of electricity were available which would bear comparison with petrol in weight, cost, and portability. The generation of electricity direct from the oxidation of coal or other fuel cannot be said to be impossible, and it may be actually within our reach if we only knew how and where to grasp it.

Nearly all the internal-combustion engines in use employ the Beau-de-Rochas or four-stroke cycle. Greater uniformity in the turning moment has been secured by having multiple cylinders, and at high speeds of rotation there would not appear to be much room for improvement in this respect. At the same time, individual impulses are not entirely damped out before they reach the road, and these leave their effect to a certain extent evident on the wearing surfaces of the tyres. It is difficult to see how a more uniform turning moment can be obtained with reciprocating engines. An engine of the rotary or turbine type would be effective, but no successful example at present exists. The moving parts of the engine, and also the explosion pressures on the pistons, can be balanced so perfectly by use of the double-piston type that, if the car is at rest, it is difficult to detect by eye or ear if the engine is running. The turning moment, however, cannot be balanced, and reacts on the whole car when running, especially at full power and slow speed, as when climbing a hill. A more perfect solution may be obtained at some future time, but it would necessitate the employment of an entirely different type of engine and transmission mechanism.

The use of the spray or jet carburettor has now become universal. The carburettor that will supply a constant mixture at constant pressure and temperature under all conditions of running of the engine is one problem which has yet to be solved. When to this has been added some device whereby this constant mixture shall be diluted with air to exactly the correct extent to give perfect combustion on explosion in the cylinder, then, and then only, will perfection in this matter have been reached. The whole question of carburation is very complex, and the author regards with satisfaction the fact that it has now been taken up seriously by scientific experimenters.

No universal method of ignition has been arrived at, though electricity in some form or other seems more nearly

to approach the ideal than anything else. The electric system of ignition enables the moment of ignition to be varied exactly as required, giving very complete control over the speed and power of the engine within limits. However, these limits constitute the weak points in what might otherwise be a perfect system. Hot as the spark is, it is unable to ignite with readiness mixtures which have more than a certain percentage of air, and the ignition, being so extremely local, prevents the flame in a weak mixture being readily transfused throughout the whole of the charge. Improvements in the original system have been in the direction of substituting mechanical for chemical means of production of the current. Owing to the fact that a slight difference in the mixture or in the amount of compression entails an alteration in the time when the charge must be ignited in order to obtain the best result, and owing to the difficulty of maintaining each cylinder of an engine in identical conditions in these respects, it is obvious that an ignition system that does not take such variations into account cannot be perfect.

The Ackermann system of steering, invented nearly 100 years ago for horse-drawn vehicles, is now almost universally employed for all road motors, except traction engines. Each of the steering wheels turns separately on a vertical pivot, which should, theoretically, pass centrally through the vertical plane of the wheel and its contact with the ground. An obstacle met by the wheel would then have no tendency to disturb the steering of the car. The said arrangement is difficult to obtain mechanically, and a compromise is sometimes made by inclining the pivots or by inclining the wheels. It is not easy to see how the best types of the present system can be improved, although it must be admitted that none is perfect.

Horizontal cylinders may be lubricated by feeding oil through a hole in the cylinder on to the piston, allowing a portion to flow through a hole in the piston to lubricate the gudgeon pin. The oil is drained away at the front end of the cylinder, and is not used again. In vertical engines splash lubrication is generally employed for the lubrication of the piston, gudgeon pin, and in many cases the crank shaft and other engine bearings. The oil in this system is thrown up from the crank chamber by the crank dipping into it. At the best it seems to be a happy-go-lucky method of a most unscientific order; the only thing which can be said in its favour is that in actual practice it has been found to work. For crank shafts and similar bearings a forced feed system would be better, provided some perfect system for road motors could be found of freeing entirely the oil from grit before re-feeding it to the bearings. Bath lubrication of gear wheels is effective as regards lubrication, but absorbs power in churning up the oil.

There is still a good deal that can be effected in design in reducing friction by the substitution of ball or roller bearings for plain ones in suitable places, and by the use of metals having a low coefficient of friction. There are many ways in which power can be lost between the engine and the road wheels. None of the many forms of friction clutch can be depended upon not to slip in the way that a clutch which is positively engaged can. The use of Hooke's universal joints involves loss in transmission, as is demonstrated by the rapidity with which they often wear. The total transmission losses are not accurately known under road conditions, but it may be indirectly estimated that such losses may amount to from 20 per cent. to 40 per cent., or even more.

The advantages of pneumatic tyres, owing to their resilience and low resistance, are counterbalanced by their high cost, rapid wear, and vulnerability. Methods of decreasing the vulnerability are only obtained at the sacrifice of other, and possibly more important, qualities. Owing to the large area of contact with the ground, and consequent low pressure per unit of contact area, the coefficient of friction is so small that skidding occurs if the road is greasy. No remedy has been found which does not impair the action of the tyre as a pneumatic one. Again, owing to the rapidity of recovery of the tyre on passing over an obstacle, oscillatory movement of the vehicle is started, and, given favourable conditions of speed and road, may be maintained, or even increased, to a dangerous extent. A partial remedy exists in the shock absorber applied between the sprung and unsprung portions of the vehicle. An inherent defect of the pneumatic tyre is its dust-raising properties. The tyre raises the dust, and the eddies produced by the passage of the car scatter it far and wide. This subject is one which is attracting the attention of the authorities representing road-makers and users. So far, the only effective remedy has consisted in treatment of the surface of the road.

The study of the composition of the exhaust gases is of importance. It ought to be possible to ensure that the exhaust gases contain not more than 1 per cent. of carbonic oxide. Governing by retarding the ignition is effective, but is objectionable on account of its liability to increase the percentage of CO in the exhaust; it is also unscientific, and very wasteful of fuel.

To obtain an average speed of twenty miles per hour, experience tells us that the maximum speed will not be less than 50 per cent. greater than the average during some periods of the journey; assuming a moderate efficiency of transmission of power, the provision of an engine capable of giving 1 brake-horse-power per cwt. of the gross weight of the vehicle and its load of passengers, &c., would not be excessive.

Deductions made from data known to be approximately correct for the speed, power, and wind area of various cars having ordinary touring bodies lead to the formula $P=0{\cdot}0017AV^2$, in which P = resistance in lb. per square foot, A = projected area of car in square feet, and V = velocity in feet per second. Experiments are needed to provide data as regards the form of car offering the least resistance to the air.

The gross ton-miles which should be obtained from a gallon of petrol of about 0·720 specific gravity at a speed of twenty miles per hour should not fall below thirty under ordinary conditions. There is room for improvement in this. Many other items, tyres especially, have to be considered, which swell the bill to such an extent as to render the cost of fuel but a small part of the whole.

The weight of a pleasure motor-car is high compared to the useful load of passengers. The useful weight in this case would be about one-quarter of the weight of the vehicle. Medium-weight passenger or goods' vehicles may carry a useful load of three-quarters the weight of the unladen vehicle; heavy vehicles having a slow speed may carry a load equal to the weight of the vehicle. It would appear that some improvement may be reasonably looked for in the reduction of the weight of the car as compared with its useful load.

Brakes on the steering wheels give immunity from skidding, but are very difficult to arrange for. It is best to apply both brakes required by law to the driving wheels, rather than to have one of them applied to the secondary transmission shaft. The distance in which a car can be pulled up without damage to the tyres on an ordinary road and under normal conditions may be approximately found from the formula $S=0{\cdot}04V^2$, where V is in miles per hour and S is the distance in yards in which the car should come to rest. At ten miles per hour it should stop in 4 yards, and at twenty miles per hour in 16 yards. These distances are greater than is desirable, and also greater than most drivers would be prepared to admit, probably owing to time, and not distance, being the factor that a driver judges by when called upon to stop quickly. Improvement is only to be sought for in increasing the surfaces of adhesion, as by braking all four wheels, or by more equal distribution of the braking effect than we have at present.

Petroleum spirit is practically the only fuel employed; other fuels which might be used are petroleum, paraffin, benzol, and alcohol. Suction gas producers may be used for the heavier classes of vehicles.

THE "BROMOIL" PROCESS.

ABOUT five years ago Mr. G. E. H. Rawlins introduced, as a practical method of making photographs, a process described fifty years previously by Poitevin. Paper coated with gelatin is sensitised by soaking it in a solution of potassium bichromate, dried, and exposed under a negative. Where light has acted the gelatin is rendered less able to absorb water, so that if the print

is moistened, and a roller charged with a greasy ink is passed over it, the ink is taken up by the print more readily where the light has produced the most change and the water has been the least absorbed. The use of rollers for the application of the ink soon gave way in favour of brushes. This process commended itself to many photographers, especially those who desired to "control" their prints, that is, to produce what they desired rather than what they were able to secure by photographic methods, for it is possible to put on much or little ink, and to reduce or increase the quantity in the various parts of the print as the taste of the worker may dictate. Obviously a wide choice of colours is available, and the method has the advantage of giving the peculiar richness and depth of tone associated with oil colours.

About a year ago it was found possible to render bromide enlargements available for this process, the silver image in the enlargement effecting the reduction of the bichromate. Thus no large negative is needed, and no exposure to light after the bromide enlargement has been made. Mr. F. J. Mortimer calls this last method of work the "bromoil" process, and he has now on view at the house of the Royal Photographic Society, 66 Russell Square, more than fifty examples of his own work. The exhibition will remain open, free on presentation of visiting card, daily from 11 a.m. to 5 p.m., until June 8. Mr. Mortimer has been known for a considerable time as the producer of fine marine and coast-scenery photographs, but here he shows also landscapes and portraits of various kinds. Those who are interested in such methods of work will get a better idea of the possibilities of the "bromoil" process by a study of these examples than they have ever had an opportunity of getting before.

ARBORICULTURE IN GERMANY.[1]

THE German Arboricultural Society came into existence in the year 1892, and now has a membership of 1800, of whom 120 attended its annual meeting in August, 1908, in Alsace Lorraine; Strassburg and Colmar being its headquarters. The president is Count Schwerin, who is ably helped by the secretary, L. Beissner, the conifer expert. The report just issued gives a detailed account of the meeting. The first three days were devoted to the reading of papers now published. Then followed visits to private parks, where many fine exotic and native trees, some of which are illustrated in the report, were seen. Each member, who was himself listed and conspicuously numbered, received a numbered list of the trees worthy of note in each centre visited. The list gave the name, girth, height, and age of each tree, with further remarks in some cases.

The lists embodied in the report may serve as an indication of the perfection of arrangement which characterised the meeting. Everything was planned to the minute, and nothing was allowed to interfere with the programme. Thus at Ollweiler Prof. Engler was in danger of being left behind after a hurried inspection of a fine specimen of *Quercus sessiliflora*, 250 years old. La Schlucht and Hoheneck gave a peep into the forests on the slopes of the Vosges Mountains. This district, with Longuemer and Retournemer, was also visited by the botanists fresh from the Botanical Congress at Strassburg, and was full of interest.

A few only of the articles in the report can be noticed. In addition to many contributions by the president, including one on the hardiness of certain trees, and one by Beissner on conifers, C. S. Sargent, an honorary member, gives an illustrated account of the Arnold Arboretum, Koehne writes on Taxodium, Forster on exotic trees, Berg on *Pseudotsuga Douglasii* in Europe, while St. Olbrich and Hübner write on trees suitable for avenues and towns, and Sprenger and Rehder on new or rare arboreous plants.

Following on more than twenty important papers there are many smaller contributions. One of these may be noticed. Unger, just returned from a residence of twenty years in Japan, proposed the cultivation of *Broussonetia papyrifera* for the supply of Japanese paper. As twenty degrees of frost is fatal to the plant, Germany was declared by experience unsuitable for the industry. Several pages are devoted to descriptions, in Latin in many cases, of new species or forms. A useful feature is a correspondence section for the supply of information on such subjects as Platanus diseases, and pitch pine. A place is also found for reviews of books on trees. Obituary notices appear, including one on John Booth, a Teutonic Scot, who strove successfully to introduce exotic timber trees into Germany, and one on George Nicholson, of Kew. Altogether the publication is astonishingly rich in contents of wide and general interest, and is very cheap.

A curious feature of the report is the entire absence of any reference to the many beautiful illustrations, there being sixteen full-page ones and many others incorporated in the text. Members of the Society, by payment of an annual subscription of five marks, obtain the report, certain privileges at the meeting, and supplies of packets of seeds as well as of living plants. This result is mainly due to the enthusiastic devotion and organising skill of the president, who has personally made all the detailed arrangements for the meeting at Cottbus in 1909, and provided the necessary particulars for two alternative places of meeting in 1910. The society would be delighted, I learnt, to visit the British Isles in the company of British arboriculturists. Cannot this be arranged for by the three British arboricultural societies?

A re-issue of the reports for the year 1892–1901, in one volume of 500 pages, at not more than nine marks, is offered for subscription. T. J.

[1] Mitteilungen der deutschen dendrologischen Gesellschaft. No. 17, 1908. Pp. 285; with many illustrations. (Bonn—Poppelsdorf: L. Beissner, Geschäftsführer der Gesellschaft.) Price 5 marks.

GROWTH OF NERVE FIBRES.

THE view that each nerve fibre develops as an independent outgrowth from a nerve-cell, finally becoming united to other tissues (*e.g.* muscle fibres) in the periphery of the body is associated especially with the name of His, and has been accepted by the majority of embryologists. Those who have worked at the question of nerve repair or have studied the mechanism of the regeneration of nerve fibres which leads to restoration of functions are divided into two camps; the majority hold, as Waller originally taught, that the nerve fibres grow in a distal direction from the cut stump attached to the central nervous system, ultimately finding their way into the peripheral segment. A minority of researchers hold the contrary view, namely, that restoration occurs in the peripheral segment independently of connection with the central nervous system.

Within the last year, Mr. Ross Harrison, of Yale, has demonstrated the correctness of the views of His in a very remarkable way. He has actually seen the fibres growing outwards in embryonic structures. Pieces of the primitive nervous tube which forms the central nervous system were removed from frog embryos and kept alive in a drop of lymph for a very considerable time; the cilia of the neighbouring epidermic cells remained active for a week or more; embryonic mesoblastic cells in the vicinity were seen to become transformed into striated muscular fibres, and there was therefore no doubt that even under these artificial conditions—rendered necessary for microscopic purposes—life and growth were continuing. From the primitive nervous tissue, and from this alone, nerve fibres were observed growing and extending into the surrounding parts. Each fibre shows faint fibrillation, but its most remarkable feature is its enlarged end, which exhibits a continual change of form. This amœboid movement is very active, and it results in drawing out and lengthening the fibre to which it is attached, and the length of the fibre increases at the rate of about 1 micromillimetre per minute. Those interested in this subject should refer to Mr. Harrison's last paper, published in the *Anatomical Record* (Philadelphia, December, 1908), where they will find figures representing the growing fibres in various lengths drawn at intervals of half an hour or thereabouts.

Such observations show beyond question that the nerve fibre develops by the overflowing of protoplasm from the central cells, and thus give us direct ocular evidence in

favour of the view which most embryologists previously held mainly as the result of circumstantial evidence. It is not surprising to find that as this and other facts all bearing in the same direction are brought to light, the prevalent idea regarding nerve regeneration after injury follows the same lines. Indeed, the number of those who hold the so-called "autogenetic theory" of nerve regeneration is being reduced nearly to vanishing point.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The Adams prize for 1909 has been awarded to G. A. Schott, late scholar of Trinity College.

The Adam Smith prize has been awarded to J. M. Keynes, fellow of King's College, for an essay on the "Method of Index Numbers."

LIVERPOOL.—On May 8 the following honorary degrees were conferred, among others:—*LL.D.*, Mr. A. J. Balfour, Lord Charles Beresford, Mr. Birrell, M.P., Sir John Brunner, M.P., Dr. Richard Caton, Lord Crewe, Sir Donald Macalister, Mr. Marconi, Lord Roberts, and Prof. Paul Vinogradoff; *D.Sc.*, Mr. Francis Darwin and Prof. J. L. Todd; *D.Eng.*, the Hon. C. A. Parsons. At a luncheon after the ceremony Mr. Balfour spoke upon the growth of the university movement. In the course of his remarks he referred to this growth as one of the most important and fruitful facts which has emerged in the experience of this generation. We live in an age of scientific discovery and industrial invention—in an age in which, from the very nature of the case, there is, and must be, a tendency to put into a less prominent position relatively, though not absolutely a less important position, the ancient studies which for centuries have occupied the educational interest and intellect of Europe. The problem to be decided is how to combine all the cultivation of these ancient studies with their newer sisters which have so much closer relation to the cultivation of the material needs of great industrial communities. There is no way of coordinating except to bring all the highest intellects concerned with both into a single organisation. It is an honour to be associated with a movement which is going to have a world-wide influence in the direction of not merely increasing industrial dexterity, but also improving and adding to the knowledge of nature, which is the greater security that the industrial and scientific movement in future shall never be divorced from those humanistic influences which have been the greatest element of intellectual progress in the history of our race.

MR. T. H. LABY has been appointed professor of physics in Victoria University College, Wellington, New Zealand.

HARVARD UNIVERSITY will lose one of the most distinguished members of its faculty in September by the resignation of Prof. G. L. Goodale, who will by that time have completed his seventieth year. Dr. Goodale has been connected with Harvard since 1872, when he was appointed instructor in botany and lecturer in vegetable physiology. In 1873 he was promoted to the assistant professorship in the latter subject. Since 1878 he has been Fisher professor of natural history and director of the botanic garden.

THE *Physikalische Zeitschrift* for April 15 contains the list of lecture courses to be given in the German universities during the summer semester. We note that at the University of Berlin seven professors and lecturers will deal with mathematics, five with astronomy and geodesy, thirteen with various branches of physics, three with meteorology, two with wireless telegraphy, twenty with the various branches of physical, inorganic, and organic chemistry, and ten with technical, physiological, botanical, and photographical chemistry.

BY a recent Act of the United States Legislature, provision has been made, says *Science*, for a biological station to be located on the shores of Devil's Lake, North Dakota. An appropriation has been made for building laboratories and providing annual maintenance. This laboratory will be well situated for the study of many interesting ecological and physiological problems, inasmuch as Devil's Lake is a large body of brackish water with no outlet, and represents the collected water supply of a large interior drainage basin. The direction of the laboratory will be under the charge of the biological department of the State University, of which Prof. Melvin A. Brannon is head.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 6.—Sir Archibald Geikie, K.C.B., president, followed by Mr. A. B. Kempe, vice-president and treasurer, in the chair.—Reciprocal innervation of antagonistic muscles. Note xiv. Double reciprocal innervation: Prof. C. S. **Sherrington**. This communication establishes that the algebraic summation of excitation and inhibition pointed out in a previous note in regard to extensor muscles holds good also for flexor muscles. In regard to the mutual action of antagonistic muscles, it shows that three types of result have to be distinguished, and that in each of these reciprocal innervation is the controlling factor. The importance of reflex inhibition for the grading of intensity of reflex actions is illustrated by various examples, in some of which the excitatory stimulus remains of constant intensity while the inhibitory is varied, and in others the inhibitory stimulus is kept constant in intensity while the excitatory is varied; in both cases a very delicate grading can be obtained even with artificial stimulation, electric and so on. The action of strychnine on the flexor inhibition is shown to be, as in the case of extensor inhibition, a conversion of the inhibition into excitation. These effects, namely, grading, algebraic summation, and conversion of inhibition into excitation, are all found readily both in the decapitated and spinal animal and in decerebrate rigidity.—Note on a curious property of neon: Prof. J. Norman **Collie**. During some work with specially pure neon, it was noticed that, as the gas escaped at ordinary pressure from a Töpler pump up through the mercury in an inverted test-tube, each bubble glowed with a fine red glow. This property is very apparent if the neon is sealed up in a glass tube with mercury, and the tube shaken violently. It was expected that the glow would always be produced when the tube containing the neon and mercury was shaken. This was found not to be the case, for it was noticed in many instances that, after shaking for some time, the glow became very feeble. These tubes could at once be brought back to their original condition by allowing a discharge to pass through them from an induction coil. Sometimes, however, when a powerful discharge was passed through them, exactly the opposite effect was produced, and further sparking did not improve them. Platinum wires sealed through the ends of the tubes did not interfere with the property of glowing when shaken. Another tube was strongly etched inside with hydrofluoric acid, also without effect on the glow. Heating the tubes strongly did not destroy the effect, but, on the contrary, restored those tubes that had been spoilt by passing heavy electric discharges through them. It was found possible to produce in this way tubes that possessed the property of glowing only at one end, or glowing at both ends and not in the middle. The slightest trace of moisture entirely stops the glow. The tubes were filled at different pressures, varying from 120 mm. to 200 mm. pressure, as it was found that the glow was as bright at these as at ordinary pressures, and a saving in neon was thus made.—The properties of colloidal systems. I. The osmotic pressure of Congo-red and of some other dyes: Dr. W. M. **Bayliss**. Congo-red, although a colloid in the sense of not being diffusible through parchment-paper and exhibiting other colloidal properties, such as those dependent on surface effects, has an osmotic pressure equal to that which would be given if it were present in true solution in single molecules. The solutions are not resolvable into particles under the ultra-microscope. The theoretical osmotic pressure is only to be obtained in the complete absence of extraneous electrolytes. Even the carbonic acid present in ordinary distilled water is sufficient to cause a marked fall in the pressure recorded. The

manner in which electrolytes produce this fall is by causing aggregation of molecules to form particles. This is the case whether acid, alkali, or neutral salt be in question. The action of a stable colloid in protecting against the effect of electrolytes is shown to consist, in the cases of congo-red and of arsenious sulphide, in the production of minute aggregates, which, although causing fall in osmotic pressure by diminution of effective concentration, are not of sufficient size to precipitate. Hence the protective power can only be regarded as a limited one, due probably to the formation of complex colloids. The free acid of congo-red forms a deep blue colloidal solution when dialysed. This is easily resolvable under the ultramicroscope, but gives a definite and measurable, though small, osmotic pressure, about 14 mm. Hg for a 1 per cent. solution. Assuming the kinetic theory to be correct, this means that the aggregates contain, on an average, twenty molecules. Estimations of the molecular dimensions of this blue colloid were made on the basis of enumeration of the particles in unit volume by means of the ultramicroscope. The values found are larger than the accepted ones for water, &c., about 100 times, in fact. The whole of the results are capable of explanation on the assumption that colloidal particles possess the kinetic energy of molecules, but lend no support to any view that postulates the necessary presence of foreign electrolytes.—The origin and destiny of cholesterol in the animal organism. Part V.—On the inhibitory action of the sera of rabbits fed on diets containing varying amounts of cholesterol on the hæmolysis of blood by saponin: Mary T. **Fraser** and J. A. **Gardner.** In an earlier paper it was shown by comparative estimations of the total cholesterol-content of the blood of rabbits that had been respectively fed on ether-extracted bran, and on the same extracted bran with the addition of known amounts of cholesterol, that some, at any rate, of the cholesterol absorbed found its way into the blood-stream. It seemed desirable to ascertain whether the cholesterol was absorbed into the blood-stream as such, or in the form of esters, or in both states, and also whether the phytosterol of vegetable food can be utilised for the formation of cholesterol in the organism. Use was made of the observations of Hausmann, Abderhalden, and Le Count, who showed that, whereas cholesterol and phytosterol inhibit the hæmolytic action of saponin, their esters do not do so. A series of comparisons were made of the inhibitory action of sera of rabbits fed on extracted bran alone, on extracted bran, and, in addition, measured quantities of cholesterol, cholesterol esters, and phytosterol, respectively, on the hæmolytic action of saponin. Care was taken to keep the animals under strictly comparable conditions, and the different sets of hæmolytic experiments were carried out under diverse conditions. *Conclusions.*—(1) When cholesterol is given with the food of rabbits, some is absorbed, and finds its way into the blood-stream as free cholesterol; only a portion of the total cholesterol given in the food is absorbed, the rest being excreted unchanged. (2) Cholesterol when in the form of esters undergoes hydrolysis in part, at any rate, during digestion, and appears in the blood-stream as free cholesterol. (3) When animals are fed on phytosterol, this substance is in part absorbed, just as in the case of cholesterol, and appears in the blood-stream either itself or in the form of cholesterol.—Some effects of nitrogen-fixing bacteria on the growth of non-leguminous plants: Prof. W. B. **Bottomley.** Bacterial cultures prepared from the algal zone of Cycas tubercles taken from below the surface of the soil always contain a species of Azotobacter associated with *Pseudomonas radicicola.* Pure cultures of these organisms were obtained, and it was found that when they are growing in association there is an increased assimilation of free nitrogen.

Control	0·48 mgr. N. per 100 c.c.
Pseudomonas alone ...	0·91 ,, ,,
Pseudomonas + Azotobacter	1·21 ,, ,,

In Cycas tubercles the bacteria live, usually imbedded in a slime, in the open spaces of the algal zone, and the projecting cortical cells presumably absorb the nitrogenous products of bacterial activity. Experiments made to ascertain to what extent, if any, a mixed culture of Pseudomonas and Azotobacter applied to the roots of other non-leguminous plants might influence their growth, the nitrogenous bacterial products being absorbed directly by the plant, gave the following results:—*Oats.*—Pot experiments with oats grown in sand dressed with phosphates, potash, and lime. Treated pots watered once with the mixed culture solution. Average weight per plant: untreated, 0·42 grm.; treated, 0·74 grm.; increase, 0·32 grm. = 76 per cent. *Barley.*—Field experiments on limed plots of 484 square yards. Seed only treated with bacterial culture. Yield per plot: untreated, 608 lb.; treated, 691 lb.; increase, 83 lb. = 13·6 per cent. The barley from a treated plot also yielded a higher nitrogen content.

	Mgr. N. per cent.	Weight of 1000 corns	Mgr. N. per corn
Untreated ...	1·55 ...	48·5 grms. ...	0·75
Treated	1·76 ...	49·5 ,, ...	0·87

Bulbs.—Galtonia candicans grown in sandy soil, manured and limed, 250 bulbs of equal size in each bed. Treated bed watered twice with mixed culture solution. Weight of bulbs when lifted and dried at end of season: untreated, 69 lb. 3 oz.; treated, 82 lb. 1½ oz.; increase, 12 lb. 14½ oz. = 18·6 per cent. *Parsnips.*—Grown in garden soil, manured and limed. Half the bed watered once with mixed culture solution. Every parsnip grown in the bed included in the weights. Untreated, 68 roots weighed 22 lb. 14 oz.; average per root = 5·38 oz.; treated, 65 roots weighed 26 lb. 10 oz., average per root, 6·55 oz.; increase per root, 1·17 oz. = 21·7 per cent. In all the experiments the soil was treated with lime before the mixed culture was applied.

Royal Microscopical Society, April 21.—Mr. E. J. Spitta, vice-president, in the chair.—The recent and fossil Foraminifera of the shore sands of Selsey Bill, Sussex: E. **Heron-Allen** and A. **Earland.**—The disappearance of the nucleolus in mitosis: E. J. **Sheppard.**

Physical Society, April 23.—Dr. C. Chree, F.R.S., president, in the chair.—A want of symmetry shown by secondary X-rays: Prof. W. H. **Bragg** and J. L. **Glasson.** When a primary X-ray strikes an atom, a secondary X-ray sometimes starts out from the place of impact. The experiments described in the paper were made with the object of comparing the intensity of emission of the secondary X-ray in a direction making an angle of about 45° with the primary with the intensity in a direction making an angle of 135°, and therefore turning back almost completely. It was found that in the case of atoms of platinum, tin or aluminium, or of such light atoms as are contained in celluloid, the former was larger than the latter, being sometimes three times as great. Madsen has obtained similar, but much greater, inequalities in the case of the γ rays. When atoms of copper or iron were tested, atoms which give rise to a very soft radiation, there was little inequality. A similar inequality effect also occurs in the case of β rays. On the original pulse theory, calculation showed that there should be no inequality of the secondary X-radiation in any case. If that theory were abandoned, and the X-rays were supposed to be bundles of energy travelling through space, there did not appear to be sufficient definition of such entities as would enable any comparison to be made between theory and experiment. If the rays were supposed to be material the facts were generally in agreement with expectation, and afforded another instance of close parallelism between the phenomena of the X and the γ rays.—Transformations of X-rays: C. A. **Sadler.** It has been shown that the members of the group of metals chromium—silver emit under suitable primary beams radiations which are homogeneous, and which increase in penetrating power with increase of atomic weight of the radiator. Using these homogeneous beams, the tertiary radiation excited by them in other metals has been studied by the author. It was found that the tertiary radiation excited in any member of the group Cr—Ag was homogeneous, and its penetrating power was that characteristic of the radiation from the substance when excited by a primary beam. With any given tertiary radiator it was found that the intensity of the homogeneous type of radiation emitted when the homogeneous radiations from the members of the group Cr—Ag successively fell upon the radiator was inappreciable unless

the exciting radiation was more penetrating than that characteristic of the radiator.—Theory of the alternate-current generator: Prof. **Lyle.** The author points out that the theory of armature reaction as ordinarily discussed by electricians is unsatisfactory, as an important effect due to the mutual induction between the current in the field winding and the current in the armature circuit is neglected. To simplify the problem, the case of a simple ironless single-phase alternator is first discussed, and then the effects of hysteresis and eddy currents. The action of "dampers" in diminishing the heat-losses in the field circuit and the theory of the synchronous motor are also discussed.

Zoological Society, April 27.—Prof. E. A. Minchin, vice-president, in the chair.—A review of the species of the lepidopteran genus Lycænopsis, Feld. (Cyaniris auct. nec Dalm.), on examination of the male ancillary appendages: Dr. T. A. **Chapman.**—(1) Some points in the structure of *Galidia elegans*, and on the post-caval vein in Carnivora; (2) the post-caval vein and its branches in certain mammals: F. E. **Beddard.**—The comparative osteology of the passerine bird *Arachnothera magna*: Dr. R. W. **Shufeldt.**

Challenger Society, April 28.—Prof. d'A W. Thompson in the chair.—Photophores in Decapoda: S. W. **Kemp.** While many decapods emit a luminous secretion from various glands, true photophores are at present known only in five species of the three genera Sergestes, Acanthephyra, and Hoplophorus; in all of them an intensely blue pigment is associated with the organ; in one the pigment is situated in the corneal lens, in the others in the (presumably) light-producing cup of cells which lies immediately behind the lens, and the general body-pigment is absent where they occur. The organs increase in number with age, and exhibit morphological stages. They are placed much as in Euphausids.—A new method of plotting currents from observations of drifters, used by the Scottish Fishery Board in the international study of the North Sea: Prof. **Thompson.** On a large chart divided into squares of 1° lat. and ½° long. all the observations were recorded by arrows of true direction and proportionate length; the "resultants" of these arrows, calculated for each square, showed a uniform cyclonic current from Shetland down and across the North Sea to Norway, in concentric belts round the area of dead water which had been shown to exist by the observations of a previous year.

CAMBRIDGE.

Philosophical Society, March 8.—Prof. Sedgwick, president, in the chair.—The nature of anthocyanin: Miss M. **Wheldale.** The communication deals with the red-purple-blue pigment "anthocyanin" occurring in plants. Following up the suggestion made by various investigators that there is some intimate connection between tannins and anthocyanin, genera from various natural orders were examined for tannin, and at the same time their pigments were subjected to the action of various chemical reagents. It was found that substances of the flavone series of natural colouring matters are widely distributed in plants, and from evidence based upon chemical tests and the results obtained in genetics these flavones appear to be essential to the constitution of anthocyanin.—An experiment on ionisation with γ rays: L. **Vegard.** The paper gives a short account of some experiments made with the object of finding whether the ionisation with γ rays is strictly an additive property. The additivity is tried for different angles between the directions of the two ray bundles, and in all cases the ionisation is found to be additive within a fraction of 1 per cent. In the introduction the author mentions that if the γ rays consist of pulses with a continuous wave-front, some departure from additivity under certain conditions was to be expected.—The nature of the ionisation produced in a gas by γ rays: R. D. **Kleeman.** It was found that when a volume of air is exposed to γ rays, and the ionisation in this volume by the secondary kathode radiation from surrounding objects is eliminated by a magnetic field, there still remains a considerable amount of ionisation due to the direct action of the γ rays on the gas. Now, it has been shown by Laby and Kaye that the ionisation in an ionisation chamber due to the penetrating radiation from the gas is small in comparison with the total ionisation. From a comparison of these two results it follows that γ rays produce, directly, δ rays, that is, kathode rays which have not sufficient velocity to produce any further ions themselves.—Uniform oscillation: Dr. **Young.**—The parametric representation of the co-ordinates of points on a cubic surface in space of four dimensions: H. W. **Richmond.**—The irreducible concomitants of two quadratics in n variables: H. W. **Turnbull.**

MANCHESTER.

Literary and Philosophical Society, April 6.—Mr. F. Jones, vice-president, in the chair.—Some colour demonstrations of the dissociating action of water: R. L. **Taylor.** When highly coloured solutions of ferric sulphocyanide and ferric salicylate are diluted with water the colour disappears. On the other hand, if a few drops only of a solution of potassium permanganate are added to half a litre of water a permanent coloration is produced. The author pointed out that the peculiar behaviour of these bodies was adequately accounted for by the "theory of ionic dissociation," according to which the ferric sulphocyanide and the ferric salicylate are dissociated into colourless ions of iron and sulphocyanide, whereas the potassium permanganate is dissociated into potassium and coloured manganic ions.—Report on the recent Foraminifera from the coast of the island of Delos (Grecian Archipelago): H. **Sidebottom.** Some of the most interesting forms described in the paper were *Polytrema miniaceum*, Linné, sp., *Truncatulina variabilis*, d'Orbigny, and a decorated form of *Rotalia beccarrii*, Linné.—Permian foot-prints: G. **Hickling.** By the aid of numerous figures the author showed the very close correspondence there was between foot-prints found in the sandstones of Mansfield, Notts, and Penrith, and those of the sandstones of Dumfries-shire and Elgin. The former rocks are undoubtedly of Permian age, but the age of the Dumfries-shire and Elgin sandstones is not definitely fixed owing to the fewness of the fossil remains found in them. The author suggested that the identity of the types of foot-prints here considered should be regarded as affording sufficient evidence to fix the age of the rocks in which they occur as Permian, and so settle a much controverted matter. This conclusion, he added, was further strengthened by the fact that not one of these forms could be matched by those found in the Triassic rocks.

EDINBURGH.

Royal Society, May 3.—Prof. Ewart, F.R.S., vice-president, in the chair.—*Strophanthus sarmentosus*, its pharmacological action and use as an arrow-poison: Sir Thomas **Fraser** and Dr. A. P. **Mackenzie.** Most of the material had been collected by members of the Colonial Medical Service in Nigeria, especially Dr. Dalziel and Dr. Dutton, and a number of poisoned arrows had been supplied by Sir Frederick Lugard. The main constituent in this arrow poison was made from the seed of *Strophanthus sarmentosus*, which resembled in its pharmacological properties those of *Strophanthus hispidus*. To determine its action an alcohol extract freed from substances soluble in ether was used. A detailed account was given of its action on the heart and skeletal muscles, both in small and large doses. The effects on the heart are the most important, small doses tending to produce a diastolic type of change and large doses a systolic type. There seem to be no direct effects on blood pressure or on respiration.—The histological changes in the liver and kidney after chloroform administered by different channels: Dr. G. Herbert **Clark.** The chloroform was administered in three ways:—(1) by inhalation; (2) in olive oil by the stomach; (3) by injection into the subcutaneous tissues of the back. By the first method the effect produced was very small. By the second method the mortality was great, and the organs underwent extensive changes and degeneration. Similar effects were produced by the third method, although the degree of degeneration was not so great. The changes were described in detail, and illustrated by microscopic slides.—The pathogenesis of *Micrococcs melitensis*: Dr. J. **Eyre.** The pathogenic effects produced by inoculation in various rodents and Carnivora were studied

in detail, the injection being intracerebral, intravenous, intraperitoneal, or subcutaneous. The question of infection was of importance in regard to the Maltese goat, and it was established by experiment that the micrococcus appeared in the milk of an infected goat. It was thus not improbable that the infection might be cutaneously carried from goat to goat by the act of milking. Man is susceptible to infection by subcutaneous inoculation, to infection through apparently intact mucous membranes, and the administration of infective food. Several cases of accidental laboratory infection, leading to acute and subacute attacks of melitensis septicæmia, were described.—Life and chemical work of Archibald Scott Couper: Prof. Richard **Anschütz.** Translated by Prof. Crum Brown. In this paper Prof. Anschütz gives a critical account of Couper's two experimental communications on benzene and on salicylic acid, and of his "new chemical theory." These papers were originally published in the *Comptes rendus* of the French Academy of Sciences within a period of less than twelve months. Couper was unfortunate with both his chief pieces of work. The presentation of the new theory to the academy was delayed, by no fault of Couper's, so that it did not appear until after the publication of Kekulé's famous paper, in which substantially the same theory was propounded. There is no doubt, as is conclusively proved by Prof. Anschütz, that Couper's work was quite independent of Kekulé's, but the delay in its publication necessarily threw it into the shade. Couper's experiments on salicylic acid were repeated by several eminent chemists, but none of them obtained Couper's results, and the general opinion was that Couper had made a mistake in the matter. It was not until twenty-seven years had elapsed that the investigations of Prof. Anschütz proved that Couper was right, and showed how his successors had failed. Couper's work was all done within one year, and nothing was heard of him by any of his fellow-chemists after 1858. Indeed, none of them knew whence he came, many supposed that he was a Frenchman, and none knew what had become of him. Prof. Anschütz and his friends made diligent search, and at last Prof. Crum Brown came upon a clue which led him to Kirkintilloch. There Dr. Whitelaw introduced him to Couper's cousins, and from them and from Mr. T. A. Dollar, London, the eminent veterinary surgeon, also a cousin, he obtained much information as to Couper's history. By a strange concurrence of circumstances Prof. Crum Brown made the acquaintance of an old friend of Couper, Geheimrat Berring, of Coblenz, who had studied with Couper at Berlin. From him much interesting matter was obtained. Couper was born on March 31, 1831, at Kirkintilloch, where his father was a manufacturer. He studied classics and philosophy in the universities of Glasgow and Edinburgh, and, along with his friend Alexander Hamilton, paid several visits to the Continent. In 1855 and 1856 he studied chemistry in Berlin, and in August, 1856, went to Paris to work in Wurtz's laboratory. He remained there until the autumn of 1858, when he returned to Scotland, and in December, 1858, accepted the post of second laboratory assistant in Playfair's laboratory in the University of Edinburgh. Near the end of that winter session his health broke down, and although he somewhat recovered, he remained an invalid, unable to undertake any kind of work, until his death on March 11, 1892. For the last thirty years of his life he lived at Kirkintilloch with his widowed mother, who survived him, dying in 1895 at the age of ninety-three. Prof. Anschütz says:—"In the history of organic chemistry the sorely tried Archibald Scott Couper deserves a place of honour beside his more fortunate fellow-worker, Friedrich August Kekulé."

PARIS.

Academy of Sciences, May 3.—M. Émile Picard in the chair.—The internal pressure of fluids and the law of intermolecular attraction: E. H. **Amagat.** The conclusion is drawn that the intermolecular attraction varies inversely as the fourth power of the distance.—A hæmogregarian of *Python sebai*: A. **Laveran** and A. **Pettit.** Nine diagrams accompany the paper, showing the parasite in various states of development. The species appears to be new, and the name *H. sebai* is proposed for it.—Singular systems of associated O networks: C. **Guichard.**—The application of Stefan's law in astronomy: Ch. **Féry.** The correction term for atmospheric absorption would appear to have been overestimated. A correction of 25 per cent. would appear to be nearer the truth than the 50 per cent. indicated by Crova.—A definition of the number of dimensions of an abstract *ensemble*: Maurice **Fréchet.**—The uniform analytical functions which remain continuous on a completely discontinuous *ensemble* of singularities: Arnaud **Denjoy.**—Remarks on the preceding communication: M. **Painlevé.**—The movement of a disc in a fluid: A. de Gramont **de Guiche.**—The use of the torsion balance as a seismograph: V. **Crémieu.**—The photographic registration of Brownian trajectories in gases: M. **de Broglie.** A microscope furnished with a camera is focussed on the gaseous suspension illuminated laterally by the concentrated beam from an arc lamp, and forms an image on the plate magnified about forty diameters. For a given size of particles the light diffused in the direction of the axis of the microscope is sufficient to make a record on very sensitive plates, in spite of the rapidity of the movements. A reproduction of such a negative is given.—The laws of the slope of water in canal of constant length and practically constant depth connecting a tidal with a non-tidal sea of the same mean level. The determination for each point of the canal of the limit of the maximum current, and the time at which the maximum current is produced: Philippe **Bunau-Varilla.**—The discontinuous discharge in a Geissler tube: H. A. **Perkins.**—The coefficients of expansion of gases: A. **Leduc.** A re-calculation of the values published twelve years ago, making use of the recently determined molecular volumes.—The fusibility of mixtures of gold and tellurium: H. **Pélabon.** The compound Au_2Te_4 is the only one indicated by the curves of fusion of mixtures of gold and tellurium; no indication was obtained of the gold telluride Au_2Te described by Margottet.—The melting point of platinum: W. **Waidner** and G. H. **Burgess.** The apparently close agreement between the values obtained for the melting point of platinum by different observers with the platinum, platinum-rhodium, or platinum, platinum-iridium thermocouples is due to the use of the same empirical extrapolation in each case. A different formula, equally well applying to the actual observations between 300° C. and 1100° C., leads to quite a different melting point for platinum. As regards the application of radiation methods to this problem, the divergence of the figures found appears to be due in great part to an insufficient knowledge of the exact value of the constant C_2 in Wien's equation $J = C_1\lambda^{-5}e^{-c_2/\lambda\delta}$.—The magnetic dichroïsm of mineral species: Georges **Meslin.**—A new automatic mercury pump: P. **Klein.** A description, with a diagram, of a modified Töpler pump. It is worked by means of an ordinary water pump, is made entirely of glass, and works without taps. A pump using about 650 c.c. of mercury gave a Crookes vacuum in a 500 c.c. vessel in fifteen minutes.—The conditions necessary for direct reactions and the sense of the electric current produced in the attack of metals by sulphur: Albert **Colson.** The heat of formation, the knowledge of which is indispensable in the study of chemical equilibrium, has not the same influence upon direct irreversible reactions which take place at a high temperature.—The physicochemical interpretation of differences of potential in living tissues: Pierre **Girard.** From a consideration of the changes of electromotive force produced in concentration cells by the interposition of an animal membrane, a physicochemical interpretation of the potential differences in living tissues is obtained.—The freezing of mixtures of water and normal butyric acid: H. **Faucon.** The acid was examined at twenty-nine different concentrations, and neither the fusion-point curve nor the microscopical examination of the separated crystals points to the formation of a definite hydrate.—The action of some oxidising agents upon silicochloroform: A. **Besson** and L. **Fournier.** Oxygen gives the known oxychloride Si_2Cl_6O, together with viscous oxychlorides of unknown composition. Silicochloroform reacts explosively with nitrogen peroxide, even at low temperatures. In solution (carbon tetrachloride) the reaction can be moderated, and corresponds mainly to $SiHCl_3 + 2NO_2 = SiO_2 + 2NOCl + HCl$, some water being also formed by a secondary reaction between

HCl and the NO_2.—The influence of the colloidal state on dyeing: Léo **Vignon.**—A new method of isomerisation in the terpene series: Géza **Austerweil.** Pinene, heated to a moderate temperature with an organic acid in sealed tubes, gives a yield of about 18 per cent. bornyl esters; if the pressure in the autoclave is raised some atmospheres by means of a bottle of carbon dioxide, the yield is much higher.—The suboxides of cæsium: E. **Rengade.** The oxide Cs_7O_2 was isolated and analysed.—Contribution to the study of the rocks of the eastern edge of the Armorican *massif*: L. **Vandernotte.**—The rational use of superphosphates: J. **Dumont.** It has been shown by cultivation experiments on the large scale that the application of superphosphate mixed with farm manure gives better results than the same manures applied separately.—The relation of insects, especially Lepidoptera, with the flowers of Asclepiadeæ, and in particular with that of *Araujia sericofera*. The mechanism of their capture: J. Künkel **d'Herculais.**—The indol-producing bodies of the urine: Ch. **Porcher.**—Bilirubin: M. **Piettre.**—The action of electrolytes on the hydrolysis of fats by the pancreatic juice: Émile F. **Terroine.**—Research on the hydrolysis of the proteins by acids: Henri **Mathieu.**—The mechanism of the synthesis of light impressions received by the compound eyes of the Diptera: P. **Vigier.**—The reproduction of Aphelinus and the individual interest in acts relating to the conservation of the species: Paul **Marchal.**—The enteroïds of the Acraspedes: Edgard **Hérouard.**—The formation of the Straits of Gibraltar: Louis **Gentil.**—The grotto of Bosse in the commune of Morée, Loir-et-Cher: Armand **Viré** and André **Piédallu.**—Some seeds and microsporangia of Pteridosperms found in the Nord coal basin: Alfred **Carpentier.**

DIARY OF SOCIETIES.

THURSDAY, MAY 13.

ROYAL SOCIETY, at 4.30.—Recent Solar Research: Dr. George E. Hale, For. Mem. R.S.—Utilization of Energy stored in Springs for the Production of Mechanical Work: A. Mallock, F.R.S.—The Elastic Limits of Iron and Steel under Cyclical Variations of Stress: L. Bairstow.—Functions of Positive and Negative Type: J. Mercer.—On a New Kind of Glow in Vacuum Tubes: Rev. H. V. Gill, S.J.

ROYAL INSTITUTION, at 3.—Newfoundland: J. G. Millais.

ROYAL SOCIETY OF ARTS, at 4.30.—Some Phases of Hinduism: Krishna Gobinda Gupta.

MATHEMATICAL SOCIETY, at 5.30.—Ternary Quadratic Types: H. W. Turnbull.—The Theorem of Gauss in the Theory of Attractions: Dr. J. G. Leathem.—On the Continuity or Discontinuity of a Function defined by an Infinite Product: J. E. Littlewood.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Economics of Medium Sized Power Stations: A Study of Comparisons between Steam, Gas and Oil Engines: A. J. J. Pfeiffer.

FRIDAY, MAY 14.

ROYAL INSTITUTION, at 9.—Solar Vortices and Magnetic Fields: Prof. G. E. Hale.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Spectroscopic Comparison of o Ceti with Titanium Oxide: A. Fowler.—On some Points with regard to the Light Fluctuations of Variable Stars. A Rejoinder to Mr. H. C. Plummer's Criticisms: Karl Pearson.—Note on certain Coefficients appearing in the Algebraical Development of the Perturbative Function: R. T. A. Innes.—On Inclined Lines in Stellar Spectrograms, and on a New Method of Focussing a Star on the Slit of a Spectrograph: J. Lunt.—Observations of Helium D_3 Absorption in the Neighbourhood of Sun-spots in 1908: Capt. R. A. C. Daunt.—Note on certain Lines ascribed to Argon in Celestial Spectra: J. Lunt.—The Long-period Variable RT Cygni in 1908: A. N. Brown.—Results of Micrometer Measures of Double Stars made with the 28-inch Refractor in the Year 1908: Royal Observatory, Greenwich.—New Double Stars: Rev. T. E. Espin.—Note on the Solar Constant and the Apparent Temperature of the Sun: C. Fery.—On Absorption in Jupiter's Atmosphere, and its Probable Effect on the Colour and Albedo of the Belts and Zones: J. H. Reynolds.—*Probable Paper*: Solar Parallax Papers, No. 7, The General Solution for the Parallax: A. R. Hinks.

PHYSICAL SOCIETY, at 8.—On a Bifilar Vibration Galvanometer: W. Duddell, F.R.S.—Effect of Temperature on the Hysteresis Loss in Iron in a Rotating Field: W. P. Fuller and H. Grace.—On a Method of Testing Photographic Shutters: A. Campbell and T. Smith.

MALACOLOGICAL SOCIETY, at 8.—Descriptions of the Animals of Two Land Shells from Perak; Skeat Expedition in the Malay Peninsula, 1899–1900: Lt.-Col. H. H. Godwin-Austen, F.R.S.—List of Mollusca from Christmas Island, Indian Ocean, and Descriptions of New Species: E. A. Smith.—Further Notes on Holocene and Recent Non-marine Mollusca from Perranzabuloe: Rev. R. Ashington Bullen.—On Non-marine Mollusca from an Early Neolithic Interment at Cuxton, Kent: A. S. Kennard.

TUESDAY, MAY 18.

ROYAL INSTITUTION, at 3.—The Hittites: (1) Monuments of Egypt and Asia Minor: Prof. John Garstang.

ROYAL SOCIETY OF ARTS, at 4.30.—Canada as a Field for British Investment: J. Obed Smith.

ROYAL STATISTICAL SOCIETY, at 5.—The Meat Supply of the United Kingdom: R. H. Hooker.

WEDNESDAY, MAY 19.

ROYAL MICROSCOPICAL SOCIETY, at 8.—On the Recent and Fossil Foraminifera of the Shore-sands of Selsey Bill, Sussex, Part ii.: E. Heron-Allen and A. Earland.—A New Illuminator for the Microscope: J. W. Gordon.

ROYAL SOCIETY OF ARTS, at 8.—Railway Development in China: A. J. Barry.

ROYAL METEOROLOGICAL SOCIETY, at 4.30.—The Anticyclonic Belt of the Northern Hemisphere: Col. H. E. Rawson, C.B.—Errors of Estimation in Thermometric Observations: A. Walter.

THURSDAY, MAY 22.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: Observations on the Urine in Chronic Disease of the Pancreas: Dr. P. J. Cammidge.—*Trypanosoma ingens*, n.sp.: Colonel Sir David Bruce, C.B., F.R.S., and Captains A. Hamerton, H. R. Bateman and F. P. Mackie.—The Incidence of Cancer in Mice of Known Age: Dr. E. F. Bashford and Dr. J. A. Murray.

ROYAL INSTITUTION, at 3.—Newfoundland: J. J. Millais.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Annual General Meeting.

FRIDAY, MAY 21.

ROYAL INSTITUTION, at 9.—Afforestation: Hon. Ivor C. Guest, M.P.

SATURDAY, MAY 22.

ROYAL INSTITUTION, at 3.—The Secret Societies of the Banks' Islands: Dr. W. H. R. Rivers, F.R.S.

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