THURSDAY, SEPTEMBER 19, 1912.

CHEMICAL TECHNOLOGY.

(1) *Bleaching and Dyeing of Vegetable Fibrous Materials.* By Julius Hübner. With an Introduction by Prof. R. Meldola, F.R.S. Pp. xxiii + 434. (London: Constable and Co., Ltd., 1912.) Price 14*s.* net.

(2) *German Varnish-making.* By Prof. Max Bottler. Authorised Translation with Notes on American Varnish and Paint Manufacture. By A. H. Sabin. Pp. vii + 363. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1912.) Price 15*s.* net.

(3) *Allen's Commercial Organic Analysis.* Edited by W. A. Davis and S. S. Sadtler. Fourth edition. Entirely re-written. Vol. vi. Pp. ix + 726. (London: J. and A. Churchill, 1912.) Price 21*s.* net.

(1) THIS is a practical manual intended for the use of students and junior employees. The purely scientific aspect of bleaching and dyeing is not within the scope of the work. As Prof. Meldola remarks in an interesting introduction, Mr. Hübner knows the theoretical side of the industry as well as anybody does . . . but his present treatment of his subject is not intended to supersede but to superadd to the scientific treatment. About one-third of the book is devoted to the description of bleaching operations, including some preliminary sections dealing with the materials employed, namely, the textile fibres, water, chemicals, and mordants. After a few pages on mercerising, the rest of the space is allotted to the discussion of dyestuffs and dyeing procedure. Practical directions for carrying out the operations are given, and frequently different methods of applying the same dyestuffs are adduced for purposes of comparison. There are numerous illustrations, chiefly of sections of machinery; and a feature of these is that in many cases they are made much more intelligible than usual by the use of a two-colour device to show the course of the fabric through the machine. The book can be cordially recommended as a concise and up-to-date compilation of practical information.

(2) Mr. Sabin is an enthusiast on the subject of paints and varnishes, and his translation of Prof. Bottler's book is far from being dry reading. The original is too concise and brief, in the translator's opinion; he has therefore added a number of notes *en passant*. These are printed distinct from the main text, and include useful bibliographical references, explanatory comments, and extensions of matters mentioned in the original or suggested by it. For example, when resenes are first referred to (as constituents of copal and other resins), Mr. Sabin interpolates a brief account of their properties, with a reference and a criticism. Hence the work may be looked upon as giving the German practice in varnish-making, annotated from the American point of view. But in addition to the running notes, Mr. Sabin contributes whole chapters also; one upon miscellaneous points in the manufacture of varnish, and one on the nature and constitution of paint; there is, further, a useful appendix of notes and references on analytical methods employed in the examination of varnishes. It is worthy of remark that, according to the translator, "our (*i.e.*, the American) methods are based upon English practice, and the English alone among foreign nations are still able to sell varnish here against our best makers."

(3) The general characteristics of the new edition of Allen's "Commercial Organic Analysis" are now tolerably familiar to users of the work, and in this connection it need only be noted that the sixth volume follows much the same lines as its predecessors. It is concerned with the chief organic bases and the alkaloids. All the latter, however, are not dealt with, some being relegated to the succeeding volume. The amines, anilines, naphthylamines, and their allies are discussed by Messrs. Davis, Sadtler, and Glover respectively. In dealing with the alkaloids, the plan has been to have first a general description of the vegetable alkaloids (this is contributed by Dr. Henry), and then to have the various groups of these products dealt with by special contributors.

It is perhaps invidious to single out any sections where all appear to be well done, but mention may be made of the articles on the volatile alkaloids and the opium group by Mr. F. O. Taylor; those on the aconite alkaloids and on atropine and its allies by Mr. F. H. Carr; and that on the cinchona group by Mr. Oliver Chick. The section on caffeine, tea, and coffee, by Messrs. Fox and Sageman, is a very useful contribution, as is also that on cocoa and chocolate by Mr. Whymper; the former is illustrated with photographs of leaves said to have been used as adulterants of tea, and by some diagrammatic sketches showing the microscopic structure of tea, coffee, and chicory.

The descriptions of the theoretical chemistry of the various products dealt with in the book appear to be trustworthy, and it is a convenience to have them in conjunction with the analytical working details. A little more careful proofreading would have detected a number of misprints.

THE GOLDEN BOUGH.

The Golden Bough: A Study in Magic and Religion. By Prof. J. G. Frazer, D.C.L. Third edition. Part v.: "Spirits of the Corn and of the Wild." In 2 vols. Vol. i., pp. xvii + 319. Vol. ii., pp. xii + 371. (London: Macmillan and Co., Ltd., 1912.) Price, 2 vols., 20*s.* net.

AT the conclusion of his elaborate study of "Spirits of the Corn," Prof. Frazer observes that "while the fine flower of the religious consciousness in myth, ritual, and art is fleeting and evanescent, its simpler forms are comparatively stable and permanent, being rooted deep in those principles of common minds which bid fair to outlive all the splendid but transient creations of genius. It may be that . . . simple folk will still cherish the simple faiths of their nameless and dateless forefathers. . . ." In his feeling for the system he has studied so long and so minutely, the Darwin of religion resembles Ernest Renan, who came to regard affectionately the Christian and Pauline subjects of his analysis.

But a more interesting point is the suggestion that superstition "springs eternal in the human breast." If there is anything in the suggestion, it is that what we know as superstitious tendencies, crystallising into religious forms, are part of the mechanical workings of the human brain. For undoubtedly these multiple variations of a few simple ideas persist, just as they first developed, in subconscious or unconscious thought. It is only the primitive explanations of belief and ritual that show conscious exercise of the brain. From a similar point of view, Adolf Bastian has remarked the deplorable sameness and the small number of the conceptions of the human mind.

Such views and such prognostications seem to forget that mental action is relative to its object, that it varies in form as its knowledge of the object, and, consequently, that science can alter, and has altered, the "principles of common minds." And, after all, this rich crop of myth, ritual, and religion, so carefully harvested in "The Golden Bough," is but the chaff of man's imagination, however persuaded he may be that it is golden grain. For the true seeds of the mind are scientific; during countless ages they were garnered in absolute unconsciousness, fancy playing meanwhile with the flying chaff.

The mistake of regarding these recurrent and multitudinous expressions of man's mental "play" as the foundation of his individual and social achievements will not be made by the synthetic sociologist of the future. He will take the logical mechanism of the mind in its relation with increasing knowledge as the foundation, and relegate the iridescent play of religion and superstition to the sphere of the imagination, as a part of æsthetics. But this "play," simultaneous with, or preceding, or following, mental adaptation to reality will be of value in determining the nature and quality of that adaptation. And the social psychologist needs no further material than that supplied in "The Golden Bough" and in "Totemism and Exogamy" for understanding the tendencies of the mind when free from scientific relations.

The discussion of "Spirits of the Corn and of the Wild" is the main stem of "The Golden Bough." Mannhardt's studies, which inspired it originally, have found a multiplex reincarnation. Besides the general extension of material there are interesting and valuable episodes, such as the connection of the Pleiades with agriculture, woman's part in agriculture, games in agriculture. A delightful essay on Empedocles as a pioneer of evolution and in comparison with Herbert Spencer shows the author's style at its best.

A. E. CRAWLEY.

SOME PHYSIOLOGICAL MONOGRAPHS.

(1) *Schutzfermente des tierischen Organismus.* By Emil Abderhalden. Pp. xii + 110. (Berlin: Julius Springer, 1912.) Price 3.20 marks.

(2) *Les Parathyroïdes.* By L. Morel. Pp. iii + 344. (Paris: A. Hermann et Fils, 1912.) Price 10 francs. (Questions Biologiques Actuelles.)

(3) *Le Goût et l'Odorat.* By J. Larguier des Bancels. Pp. x + 94. Paris: A. Hermann et Fils, 1912.) Price 3.50 francs. (Questions Biologiques Actuelles.)

(4) *The Physiology of Protein Metabolism.* By Dr. E. P. Cathcart. Pp. viii + 142. (London: Longmans, Green and Co., 1912.) Price 4*s.* 6*d.* net. (Monographs on Biochemistry.)

(1) PROF. EMIL ABDERHALDEN is probably about the busiest physiological investigator at the present day; he is certainly the most prolific writer. Not only do original papers flow in a steady stream from his laboratory, but he has also the time and energy to edit and write books. The work mentioned above is one of the most recent of these, and in it he collates the results of his own work and that of others on one of the most interesting developments of recent biochemical study. It deals with the protective mechanisms of the body, and especially with the part played by enzymes in resisting the effects of introducing foreign material into it. This is only part of the large subject included under the general heading of Immunity, but it is an important part. It is, for instance, well known that if "peptone"

is introduced into the blood-stream a very serious train of symptoms results which may terminate fatally. Healthy blood contains no enzymes capable of splitting peptone into its simpler and more harmless constituents. But by educating an animal by gradually introducing successively increasing doses of the poison, the blood acquires the property of dealing with it, owing to the genesis of peptolytic enzymes. This is only one example of the sort of thing which is continually occurring; many others are given, which the reader must discover for himself. The little book is valuable also because it deals clearly with the methods, especially the so-called "optical method," which have been elaborated by the author for the detection of the enzymes in question.

(2) The parathyroid glands were only discovered in 1880, and their importance in the life of the organism was not recognised until some years later. Removal of the thyroid body produces results analogous to those which occur when this organ is the seat of disease. Now that its neighbours, the parathyroids, have been recognised, much controversy has centred around the question as to how much of the effect is due to removal or disease of the latter bodies rather than of the thyroid itself. Much difference of opinion still prevails, but it is pretty generally admitted that what is known as tetany is a symptom rather of parathyroid than thyroid insufficiency. The main facts and views are set out with admirable lucidity in the second book mentioned above, and Dr. Louis Morel, the author, is to be congratulated, not only on having written such an interesting book, but on having added to it a valuable bibliography of the subject. This extends over nearly twenty closely printed pages in double columns, and seeing the recent date of our knowledge even of the existence of these little organs, we have an illustration of the industry of modern physiological and pathological investigators.

(3) The next monograph on our list is published in the same series, which is being published under the editorship of Prof. Dastre. In it, Dr. des Bancels gives the most up-to-date information regarding the two special senses, taste and smell.

(4) Dr. Cathcart's contribution to the biochemical monographs which Messrs. Longmans are publishing deals with the important subject of protein metabolism. This also is enriched with an excellent bibliography. Although one must admire the way in which the author has placed before his readers all the latest information on the complex problems involved, one is naturally disappointed to find how many of these still continue in an uncertain state. That, however, is not Dr. Cathcart's fault, and we must rejoice that he has himself done so much in the way of research to illuminate the dark places of scientific knowledge. It can only be a question of time and hard work before our difficulties in the interpretation of facts will disappear. W. D. H.

OUR BOOKSHELF.

Die Radiumkrankheit tierischer Keimzellen. Ein Beitrag zur experimentellen Zeugungs- und Vererbungslehre, by O. Hertwig. Pp. iii+164+Taf. i–vi. (Bonn: F. Cohen, 1911.) Price 8 marks.

THE author has planned and carried out a comprehensive series of experiments with a view to ascertain the effect of exposing to radium the ova and spermatozoa of animals, and of exposing the normal embryo in various stages of its development.

The axolotl and the frog (*Rana fusca*) were used in the experiments. The results show that exposure to radium leads, at every stage, to imperfect development of the embryo; numerous illustrations (in the text and in six special plates) show that inhibition of development and abnormal development are readily produced.

The book is divided into three parts; the first and second parts deal with experiments on amphibian ova and embryos; the third part with those of echinoderms.

The first part describes the results of irradiating fertilised ova at the beginning of segmentation, and the male reproductive cells before fertilisation. The second part describes the changes following exposure of the normal embryo at the several characteristic stages, such as the gastrula stage, the development of the nerve-plate, and of the spinal cord.

A number of microscopical sections are included in the illustrations to show the far-reaching nature of the changes produced by exposure to the rays of radium.

Antropologia Generale. Lezioni sull' Uomo secondo la Teoria dell'Evoluzione. By Prof. Enrico Morselli. 671 figs.+1 plate+3 maps. (Turin: Unione Tipografica, Editrice Torinese, 1901–1911.)

FROM 1887 until 1908 Prof. Morselli, who is by profession a physician, devoting himself to the study and cure of mental diseases, has been in the habit of delivering free courses of lectures on anthropology. The lectures, which have been in the course of publication, by instalments, for a number of years past, have now been completed, and form a work which represents a monument of patient and painstaking industry. In its conception and execution this work resembles the treatises which are so often produced by men attached to German universities.

Prof. Morselli's personality is never obtrusive: he seeks to express the facts as seen and rendered by others; he keeps his own opinions in the background. In the preface he acknowledges his indebtedness to Haeckel. "Antropologia Generale," however, is even wider in its scope than the "Natural History of Creation." The opening lectures are devoted to a historical account of the various hypotheses which have been formulated regarding man's origin and evolution, and to the bearing of Darwin's work on the modern problems of anthropology. The following chapters have even a wider sweep; they deal with life, the conditions of life, as far back in the world's history as human imagination can reach. Embryology, growth, anatomy, and all the various kinds of knowledge which have even a remote bearing on the human body are woven into the subject-matter of Prof. Morselli's lectures.

The chapters dealing with extinct and past forms of men are very complete. One is rather surprised to observe that he accepts in good faith all the discoveries of ancient man which have been made in South America in recent years. The concluding lecture pictures the man of the future as a form of Greek god. The numerous illustrations, although they have often little connection with the part of the text in which they appear, are well executed, and have been selected from many standard works and original papers.

The work is so ambitious in aim and so wide in its scope that it is impossible for any single man to obtain a first-hand knowledge of all its parts; few could have completed so successfully the task which Prof. Morselli imposed on himself.

An Outline of the Russo-Japanese War, 1904, 1905. By Col. Charles Ross, D.S.O. Vol. i., Up to, and including, the Battle of Liao-Yang. Pp. xxv+490+14 maps. (London: Macmillan and Co., Ltd., 1912.) Price 10*s*. 6*d*. net. (Military Text-Books.)

THIS account of the latest of the great campaigns of modern history takes the story up to the close of the first stage of the Japanese advance into Manchuria, which was marked by the complete and final severance of the field army under Kuropatkin from the troops interned in Port Arthur.

Naturally in so comparatively short a work it has been impossible for the author to enter into any discussion of tactical problems or to refer to the doings of the smaller units, whether in action or during the various strategical movements of the campaign. He has succeeded, however, in giving a very clear view of the earlier phases of the war, and of the numerous influences that guided the actions of the opposing commanders.

The chapters dealing with the war itself are exceedingly clearly written, and the contrast between the divided counsels that confused the Russian strategy and the impassive unanimity that ruled the movements of the Japanese is well brought out. As one would expect from an author bearing the name of Ross, not only are the facts clearly stated but the lessons to be learnt from them are philosophically discussed. The book should be read by all who desire to get a clear view of the campaign, unencumbered by technical detail, or to realise the effect on the art of war of modern scentific advances. C. H. M.

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.]*

Practical Mathematics.

IT is surely rather a pity that Prof. Perry concluded his letter with such a violent attack on the "professional mathematician." If he had attached a little less importance to Sir William White's address and a little more importance to the proceedings of, and reports presented to, the Educational Section of the Congress, I think he would find ample justification for withdrawing, or at least qualifying, his statement that the teacher "never studies his pupil," or that "the poor average English boy is never studied by the professional mathematician."

One of the main changes that is taking place at the present time consists in the introduction of the calculus at a much earlier stage in our mathematical curricula than was ever dreamt of fifteen years ago. Surely this and many other equally important changes owe their inception largely to what has often been described as the "Perry movement." After all, only a small percentage of the boys who study mathematics at school intend to qualify for the engineering profession. It is in connection with the education of the large body of pupils who learn mathematics as part of a general education that the introduction of the practical element is producing the most beneficial results. G. H. BRYAN.

Weather and the Ultra-violet Radiations of the Sun.

I WAS rather astonished by Dr. Carl Ramsauer's second letter in NATURE of June 13, which has just reached me, and although "the weather of 1911" is rapidly becoming ancient history, and I have much reluctance in pursuing the discussion of it, it is hoped that the long distance which separates me from the editorial room will be sufficient apology for asking your indulgence at this late day in order to register a protest against the conclusions enunciated in that letter.

I regret having to acknowledge that, to me, the letter appears of the nature of a *lucus a non lucendo*. If Dr. Ramsauer advances as a theory, well substantiated by experiment, that ultra-violet solar radiation is the chief source of condensation nuclei in the atmosphere, and cites in support of his theory diminished ultra-violet radiation and a hot and dry summer, with clear skies, in the northern hemisphere during 1911; and if, upon learning that, simultaneously with the existence of drought conditions in the north, there was excessive precipitation in the southern hemisphere, he can conclude that his theory is thereby fortified, in fact, universally confirmed, then he surely owes it to science to support this conclusion by convincing evidence. This should be something more than a mere supposition that the aqueous vapour which diffused into the hot summer atmosphere of the north, not encountering in the free air proper vehicles (provided by solar ultra-violet waves) for returning to the earth's surface, thereupon rushed to the southern hemisphere, where, in lieu of condensation nuclei provided by solar ultra-violet waves, it was pleased to avail itself of the facilities afforded by the ordinary laws governing gaseous bodies in order to get back to *terra firma*. According to what Dr. Shaw has written, it is evident that the laws of gases operated with full vigour in the northern hemisphere during the summer of 1911.

If, as Dr. Ramsauer contends, ultra-violet solar radiation is the *chief source* of condensation nuclei, and if normal ultra-violet radiation is a necessary condition for normal precipitation of aqueous vapour from the atmosphere, and if during periods of diminished activity in this part of the solar spectrum we are to expect the heaviest precipitation over one-half of the world, then it logically follows that the existence *in excess* of condensation nuclei produced by ultra-violet solar rays is a preventive of rain.

Not to pursue farther for the moment this function of ultra-violet radiation, it may be confidently stated that orthodox meteorologists will view with suspicion the simple conception of rapid and general distribution of vapour through the atmosphere embraced in Dr. Ramsauer's supposition. According to a well-established law of physics, the quantity of vapour which may exist in a given space is conditioned upon the temperature of the vapour and the pressure exerted upon it; consequently, in speaking of the aqueous vapour of the atmosphere, it may be said, without widely deviating from the truth, that the temperature of a given volume of air is the controlling factor determining the quantity of vapour which may exist therein. It has been well established by observation that the spontaneous diffusion of vapour in the air is a rather slow process, and that its general distribution through the atmosphere is chiefly effected by the winds and the currents of the general planetary circulation.

Dr. Ramsauer suggests no explanation as to the manner in which the vapour from the northern was translated to the southern hemisphere. The assumption that it was by the process of diffusion implies supersaturation in the upper air; and as to that condition we must hold, with Dr. Shaw, "that it has never been demonstrated." Numerous observations in the lofty atmosphere made in practically all parts of the world, by means of balloons and kites, show that the quantity of vapour decreases in nearly a geometrical progression as the elevation above the surface increases arithmetically, so that even at a moderate height a region is reached in which the water equivalent of its vapour content may conveniently be expressed in barrels instead of billions of tons—a quantity inadequate to account for excessive rains over a large portion of the earth. With such free distribution of vapour in the atmosphere as Dr. Ramsauer suggests, it would be difficult to account for the arid regions of the earth; since atmospheric overturnings are most frequent and most violent over such regions, enough vapour would be condensed to convert them into fertile regions. Indeed, the arid regions furnish evidence of the most conclusive kind that the lowest stratum of the atmosphere constitutes the "physical laboratory where rains and dense clouds are made," since they are all flanked to windward by mountain barriers which abstract the life-giving vapour from the air.

It is highly probable that during the earth's dawn the vapour of the atmosphere was saturated, as it is supposed to be now on Venus, but the irregularities introduced by continental upheavals have been the means of draining the moisture to such an extent that the air over all continental interiors and in all regions high aloft is now prevailingly dry.

If it be assumed that a mere preponderance of vapour over a given region would cause a rapid outflow to regions where the air is less charged, then there might arise a number of complicated conditions much more difficult to explain than the "weather of 1911." For instance, to cite an extreme case, the mean vapour tension over the desert of Sahara is about the same as that over central Europe and southern England; consequently it must be in excess over the desert during probably half the time, and it might therefore be concluded that much of the rain and verdure of central Europe and England is due to the vapour coming to those regions from the heart of the African desert. The relative conditions over Europe and the desert are chronically similar to those which characterised the weather of Europe and South America during 1911.

If the semi-annual exchange of vapour between the hemispheres really took place, as suggested by Dr. Ramsauer, it would probably cause disaster throughout the northern half of the world during periods of diminished ultra-violet radiation. For while the southern hemisphere might easily accommodate the vapour emanating from the limited water surfaces during the northern summer, six months later, with the boundless southern oceans seething under the perihelion sun, the quantity of vapour sent across the equator would quickly impart a decidedly martian aspect to the northern hemisphere.

In discussions of summer weather, an important physical fact is generally overlooked, one which is rarely referred to with proper stress even in treatises on meteorology, viz. the remarkable increase in the tension of saturated aqueous vapour after passing the temperature of 30° C. The energy of solar rays falling upon the ocean surfaces, the chief source of vapour supply, is almost wholly used up in converting the water into a gaseous state, so that the temperature of the water surface varies but slightly during a season; whereas the energy of the rays falling on land areas is chiefly exhausted in heating the soil and dust particles suspended in the air, and thus indirectly heating the air in contact with those solid bodies and causing land temperatures in the lower atmosphere to vary through wide limits. So, while the ocean gives off a nearly constant supply of vapour at a uniform and relatively low temperature during the summer, the so-called capacity of the continental air for vapour increases enormously once the midsummer temperatures are reached, making it increasingly difficult for atmospheric overturnings to bring about condensation unless rains have been sufficiently distributed over the land during the late spring and early summer to compensate for this large saturation deficit which would otherwise be caused by intense solstitial insolation.

This relation between temperature and vapour tension sufficiently explains the barren islands of tropical mid-oceans, as well as the clear skies and "dry spells" of the great majority of summers; and it also points to the red end as the portion of the solar spectrum chiefly responsible for "the weather of 1911."

I have no desire to question the statement that ultra-violet rays do produce condensation nuclei; the portion of Dr. Ramsauer's first letter which struck me as open to debate is the statement that ultra-violet solar radiation is the *chief source* of condensation nuclei in the atmosphere. One of the ablest investigators of the day has recently said, in treating of another branch of terrestrial physics, "it is in any case to observation that we must turn as the touchstone by which to try theory." During the past nine years I have made many observations of the relative intensity of ultra-violet solar radiation in the northern hemisphere, on the ocean, and in the southern hemisphere, with the hope of witnessing some phenomenon in nature that might furnish evidence of this power of ultra-violet rays so conclusive as the results obtained in laboratory experiments. Only once have I had reason to think (for a short time) that my efforts were being rewarded.

Although Dr. Ramsauer concludes that ultra-violet solar radiation was at a minimum phase during 1911, during the first half of March of that year I obtained the highest values for all the years of my measurements. About 10 a.m., March 11, just after the highest maximum had been recorded, a surprisingly sudden decrease in intensity was indicated by the actinometer; no cause for the change was discernible in the deep blue of a perfectly clear sky, and observations were repeated as rapidly as possible until 10.45 a.m., when the intensity had become very weak and filmy clouds could be seen in the zenith in an incipient stage of formation; by 11.30 the whole sky was overcast with an alto-stratus formation. During this time no change was registered in the brisk, warm, northerly wind which had been blowing since early morning, and the pressure, though slightly below normal, showed the normal variation for this time of day; so it seemed that the ultra-violet rays had at last displayed their powers in an unquestionable manner. But after the upward turn in the diurnal pressure curve set in, about 2 p.m., the barometer rose at an unusual rate, and by sunset a strong, cold, southerly wind was blowing, thus showing that the transformations in the upper air of the forenoon were due to the advance portion of a pressure wedge overflowing the warm and relatively moist surface current. It may be added here that no rain fell anywhere near the place of observation for several weeks after this display (although March is still well within the rainy season of this region), nor have I, up to the present time, heard of such general and heavy rains over the earth during the latter part of the month as would commensurate with such unusual activity in the ultra-violet field of the sun.

Dr. Ramsauer may claim that the mere fact of condensation is sufficient proof of his theory, and this brings up another matter referred to in his first letter which I shall discuss briefly. He says:—"If we neglect the purely local formation of nuclei in large centres of industry, the ultra-violet . . . radiation of the sun is chiefly responsible," &c., implying that condensation can take place only on an infinitely small number of the solid impurities sustained in the air. There are probably not so many factory chimneys on the whole continent of South America as there are in London, yet within the past few days an area of several hundred thousand square miles in the central section of this continent was covered by a shallow fog caused by dust particles, raised by the high winds of a "dry cyclone," cooling by radiation into the calm air of a rapidly following high-pressure area. This is only a single instance of a phenomenon which is very common indeed during the fall and winter in all regions of the temperate zones, and it goes to show that clean dust particles raised by the winds from virgin soils are quite as effective as condensation nuclei as the particles of waste products which escape through the chimneys of manufacturing towns. If dust particles can act so efficiently as nuclei in the low-lying strata, why should they be denied this agency when they appear in the higher regions of the atmosphere? For their existence in those regions, even far out into interplanetary space, is impressively evidenced by the brilliancy of the twilight glow, the meteor tracks, and the zodiacal light.

L. G. SCHULTZ.
Oficina Meteorológica Argentina, Observatorio Magnético, Pilar, Córdoba, July 26.

Antiquity of Neolithic Man.

RECENT excavations in St. Helier, Jersey, have brought to light the following evidence bearing on the antiquity of Neolithic man:—

The soil beneath the town of St. Helier is, in descending order, composed as follows:—

(1) A deposit of blown sand and recent alluvium from 4 ft. to 6 ft. thick.

(2) A bed of brown sandy and clayey peat (with relics of Gallo-Roman times).

(3) A marine deposit, consisting of clay, shingle, and shell-gravel, from 2 ft. to 5 ft. thick.

(4) A bed of firm black peat and forest remains which ranges from 5 ft. to 14 ft. in thickness.

This peat and forest bed is traceable to the shore, where it forms the well-known "submerged forest," thence (as revealed by the dredge) across the channel that separates the island from the continent, and along the continental coast from Cape La Hague to Finisterre.

This no doubt is all one with the post-glacial submerged forests of the British Isles and north-western Europe in general, for all through the flora and fauna are the same, viz. oak, alder, birch, hazel, Juncus, and Equisetum, with hazel nuts in profusion. *Bos longifrons*, red deer, and wolf, even elytra of the little purplish-green beetle, *Geotropus vernalis*, are present in this layer beneath St. Helier, as they are from extreme north to south throughout the vast forest area.

This deposit, then, marks the period of the commencement of land elevation which followed the subsidence of glacial times, for it lies immediately upon unmistakable rubble-drift and blue marine clay.

Neolithic relics, in the way of stone implements and fragments of pottery, are very plentiful on the surface, and in the upper levels, of this forest bed, but, so far as I can ascertain, have never been recorded from the strata beneath.

In a series of excavations now in progress for the foundations of a building in St. Helier, the strata as above described have been cut through, and in the blue clay *beneath the forest bed* (which here is 8 ft. thick) were found Neolithic implements as follows:— (1) A squared block of diorite about 6 in. in width and in breadth, and about 2 in. thick, which has been used as an anvil, apparently for chipping flints. It is deeply scored on both sides. (2) A flat sandstone pebble about 4 in. in diameter, which has been used in the same way. (3) A flat pebble of dolerite about a foot in length, 4 in. wide at one end, and running to a point at the other.

This pebble has served three purposes, for it is worn and abraded on the broad and fairly sharp end, showing that it has been used as an axe; again, on the sharpest lateral edge, indicating use as an ordinary meat-chopper; finally, it is scored with many cuts on the flat surfaces, having apparently been used as an anvil for chipping flints. (4) Two good specimens of the very typical flat pebble implements of elongated triangular form, bevelled at the broad end—a crude form of implement which has persisted until the dolmen period, and occurs plentifully amongst the latest Neolithic relics.

Besides these there were numerous flint chippings, cores from which flakes had been struck, and some crude flint implements with no characteristic detail.

In the same stratum as these, and in a layer of yellow clay which lies beneath, flint implements of decided Chellian, Acheulian, and Mousterian types are frequent, but the relics above specified are very clearly and decidedly Neolithic.

As the portion of the forest bed at this spot must represent the vegetation that first fringed the land as it recovered from the depression of glacial times, and these relics lie beneath it, we cannot but conclude that the Neolithic races date from a period far more remote than has usually been assigned to them, and that they must, in fact, date back nearly into the last glacial period.

Question may arise as to the possibility of a disturbance of the area by floods or other agencies, and the possible mixing up of the relics, but the excavations have been closely watched and studied by myself and several fellow-members of the local Archæological Society, and if there is one point clearer than another it is that there has been no such disturbance. The tree stumps in the overlying forest bed are as they grew, with their roots passing into the underlying strata, and everything indicates quiescence. Nor could the objects have sunk through the peat, for of the abundant stones in the overlying deposits, none have even penetrated the surface; the material is too compact to admit of this.

These interesting relics now form part of the extensive and ever-growing collection in the museum of the local Archæological and Antiquarian Society, the Société Jersiaise.

It would be interesting to know if any of your numerous archæological readers have found evidences of Neolithic man at this geological horizon.

Jersey, August 28. J. SINEL.

The Structure of the Ciliary and Iris Muscles in Birds.

MAY I be allowed through your columns to direct the attention of physiologists and anatomists to certain special features in ocular accommodation, and in the movements of the iris in birds, and to a peculiarity of the ciliary muscle and sphincter of the pupil, which, so far as I have been able to ascertain, has not been previously described?

If the eye of any bird in which a light-coloured iris sharply contrasts with a black pupil be carefully watched, rapid changes in the size of the pupillary opening may be sometimes observed to take place during the few moments that the bird is fixedly looking at any object under the same intensity of illumination. Moreover, the character of these movements strongly suggests that they are under voluntary control.

The pupillary reaction to light is very rapid in birds; the recontraction following the transient dilation which accompanies the momentary closing and opening of the eyelids and nictitating membrane in the movement of blinking is so rapid that the contraction of the pupil seems to coincide with the re-opening of the eye, and not definitely to follow it as in man.

Atropine seems to have no effect in dilating, or Eserin in contracting, the pupil; neither does the former seem to affect accommodation in birds.

In connection with these facts it is also interesting to find that the ciliary muscle and the sphincter of the pupil in birds are both composed of striated fibres of the voluntary type, and not of plain unstriped muscle fibres as in man and other animals.

Thus, while in man with binocular vision the delicate movements of accommodation and the associated movements of the pupil are carried out by involuntary muscles, in birds, in which in many species vision is of the monocular type, the same movements are performed by voluntary muscles.

The extremely accurate and rapid movements of the beak in birds no doubt require a corresponding delicacy and rapidity of ocular accommodation at very short range.

Other interesting questions arise as to the representation of these intrinsic eye movements in the avian brain. The matter is also one of phylogenetic interest, and I hope to publish further histological details with photomicrographs of sections shortly. C. J. BOND.

Leicester, August 30.

The Attacks of Birds upon Butterflies.

MR. EVERSHED'S letter in NATURE of August 29 seems to me very suggestive, and it is to be hoped that his hypothesis may be tested by careful observation in many parts of the world. As regards the rarity with which these attacks have been witnessed in India by Mr. Evershed and many other naturalists, it is well to bear in mind the probability that the proportion of butterfly-eating birds differs in the different tropical regions. Indeed, it is difficult on any other hypothesis to understand why butterfly mimicry should be developed to such very different degrees in the three richest regions, being transcendent in the Neotropical, remarkable in the Ethiopian, but relatively poor in the Oriental region. Indirect evidence of the frequency of attacks in different areas might perhaps be obtained by a study of the relative amount of damage which could only have been inflicted by the beak of a bird. E. B. POULTON.

St. Helens, Isle of Wight, August 26.

A Flower-sanctuary.

IN reply to Sir Edward Fry's inquiry (NATURE, August 29, p. 661) as to the powers of county councils to protect particular flowers, I am now enabled, through the courtesy of the clerk to the Cornwall County Council, to send a copy of the by-law referred to; it is given below. It is obvious that the Somerset County Council must possess the same powers as the Cornwall County Council, and that a by-law on these lines would meet the requirements of the case, and I venture to hope that Sir Edward Fry will exert his influence in favour of the enactment of such a by-law.

FRANK H. PERRYCOSTE.

Higher Shute Cottage, Polperro, Cornwall, September 12.

County of Cornwall.—By-law for the Good Rule and Government of the Administrative County of Cornwall, made in pursuance of the Local Government Act, 1888, by the County Council of the said County, at a meeting held at Truro, on the 6th day of November, 1906, at which not less than two-thirds of the whole number of the Council were present:—

"No person shall (unless authorised by the owner or occupier, if any, or by law so to do) uproot or destroy any Ferns or other Wild Plants growing in any road, lane, roadside, waste, wayside bank or hedge, common, or other public place, in such a manner or in such quantities, as to damage or disfigure any such road, lane, roadside waste, wayside bank, or hedge, common or other public place. Provided that this by-law shall not apply to persons collecting specimens in small quantities for private or scientific use.

"Any person offending against this by-law shall be liable to a penalty not exceeding five pounds."

THE SUMMER OF 1912.

THE summer of 1912 has proved so thoroughly unsummerlike, and has been so marked a contrast to the abnormally fine and hot summer of 1911, that a few facts may be of interest. The period dealt with will be limited to the three months June, July, and August.

The drought experienced in April, followed by a general deficiency of rain in May, rendered the early summer rains in June agreeable rather than otherwise, but the wet weather soon became too persistent, and the frequent rains have been a special feature of the past summer. With the exception of a period of eight days, July 10 to 17, the weather throughout was unusually cold, and this was really the only dry period experienced over the country generally.

The following table gives the summary of temperature, rainfall, and duration of bright sunshine issued by the Meteorological Office for the several districts of the United Kingdom for the past summer (thirteen weeks ended August 31), and the corresponding results for the summer of last year have been added:—

District	Temperature: Accumulated number of day degrees above 42°		Rainfall: No. of days with rain		Rainfall: Total fall		Sunshine: Hours recorded	
	1912	1911	1912	1911	1912	1911	1912	1911
					In.	In.		
Scotland, North . .	997	1211	56	53	10·38	10·62	291	476
Eastern								
Scotland, East . . .	1063	1370	57	43	10·18	5·78	237	574
England, North-east	1284	1679	65	34	12·86	6·64	309	663
England, East . . .	1553	1911	57	29	12·25	3·83	473	759
Midland Counties .	1371	1832	60	28	13·28	4·13	346	687
England, South-east	1524	1940	55	24	10·58	3·32	473	838
Western								
Scotland, West . .	1213	1477	58	49	12·45	8·28	364	631
England, North-west	1314	1681	64	39	13·83	6·74	364	705
England, South-west	1369	1829	65	29	16·74	5·57	382	772
Ireland, North . . .	1105	1461	62	45	13·27	7·29	355	565
Ireland, South . . .	1237	1679	70	43	15·04	7·52	373	622
English Channel . .	1510	1929	65	27	14·21	5·49	510	861

The foregoing table shows that the highest temperature during the past summer occurred in the east and south-east of England and in the Channel Islands, and the temperature for the recent summer is largely in defect of that last year in all districts. In the Midland counties and in the south-west of England the day degrees above 42° are respectively 461 and 460 less than last year, which gives a deficiency of temperature of 5° for the whole period compared with 1911. The deficiency of temperature this summer compared with that of 1911 exceeds 4° in all the English districts except in the east of England, where it amounts to 3·9°.

The exceptionally heavy rains of August have greatly augmented the aggregate rainfall for the past summer over nearly the whole of Great Britain. At Darwen the fall for the month was 11·10 in. and at Norwich 10·50 in., the latter being more than four times the average; of the large total at Norwich 7·34 in. fell in the twenty-nine hours ending 9 a.m. August 27, and similar falls in the neighbourhood resulted in exceptionally severe floods. At Kew, the London reporting station of the Meteorological Office, the aggregate rainfall for August was 5·18 in., which is more than double the average, and it has only been exceeded once in August in the last fifty-seven years, 6·50 in. being measured in 1878; and there were only two days, the 1st and the 9th, absolutely without rain during the month.

The number of rainy days for the past summer is more in excess of the normal in the English districts than elsewhere, whilst the quantity of rain is largely in excess everywhere except in the north of Scotland, where it is seen from the table that the aggregate rainfall for the three months was less than in 1911.

The returns for the summer show that the heaviest rainfall occurred in the south-west of England, where the measurement was 16·74 in., which is 8·17 in. more than the average of the last twenty-five years. In the Channel Islands the excess was 7·45 in., and in the Midland counties 6·23 in. The rainfall for the closing week of the season amounted to more than seven times the average in the east of England.

The duration of bright sunshine was everywhere largely deficient, and the table shows that the amount in the several districts is only about one-half of that for the corresponding season in 1911.

The following results from the Greenwich observations exhibit in a very striking manner the exceptional character of the past summer, and the results for the summer of 1911 are also given to show the contrast:—

Period	Temperature: Mean max. or highest day			Temperature: Mean min. or lowest night			Rainfall: Days with rain		Rainfall: Total		Sunshine: No. of hours	
	1912	1911	Avge. 70 Years	1912	1911	Avge. 70 Years	1912	1911	1912	1911	1912	1911
	°	°	°	°	°	°			In.	In.		
June . .	70	71	71	50	50	50	18	12	2·34	2·11	219	224
July . .	75	81	74	55	55	53	11	3	1·25	0·26	164	335
August .	67	81	73	51	57	53	26	8	4·38	1·35	114	260
Summer .	71	78	73	52	54	52	55	23	7·97	3·72	497	819

It is seen that August is in every way the most exceptional of the three recent summer months. The mean of the day temperatures is 14° lower than in August, 1911, and the mean of the night temperatures is 6° lower. There were only five days without measurable rain, both the rainy days and the amount being more than three times as great as in 1911, whilst the duration of bright sunshine was less than one-half.

There were twelve days in the past summer with a shade temperature of 80° and above, whilst in the summer of 1911 there were thirty-seven such warm days, the average for the last seventy years being thirteen days. There were forty-five days this summer with the temperature 70° or above, and in the summer of 1911 there were seventy-three days with that temperature, the average for the past seventy years being fifty-nine days. The highest shade temperature in August this year was 73°, whilst in August last year it rose to 100°, the reading being a record for Greenwich.

The controlling factor of the weather over the British Isles during the past summer has been the unusual distribution of atmospheric pressure in our neighbourhood. During almost the whole of the summer a region of high barometer has been situated in the Atlantic to the south-west of our area, and a second region has been situated either over Iceland or Scandinavia. This has left a free passage over the British Isles for incoming disturbances from the Atlantic, and these have become imprisoned within our area, moving very sluggishly on their easterly track, and at times remaining practically stationary.

A feature of especial interest due to the unusual wind circulation set up by the abnormal atmospheric distribution was the exceptionally high temperatures which prevailed over Scandinavia during the first half of August, whilst in the British Isles and in other parts of western Europe the weather was peculiarly dull and cold. For the week ending August 12, the mean of the maxima or highest day readings at Haparanda was 80°, at Bodö 74°, and in London and at Jersey 63°; whilst at Lisbon the mean was only 76°, and at Nice 78°.

The temperature of the sea-surface in the North Atlantic and in proximity to our coasts has for some time past been much below the average.

CHAS. HARDING.

CHIRIQUIAN ANTIQUITIES.[1]

PROF. G. G. MACCURDY, of Yale University, has taken advantage of the fine collection of antiquities from Chiriqui under his charge to present to students a very valuable and interesting monograph, which is illustrated, in the usual lavish and artistic manner of our colleagues in the United States of America, by 384 figures in the text, 49 plates (five of which are coloured), and a map. The ancient cultured people of Chiriqui are apparently represented by the Guaymi, whose language shows affinity with that of the Chibcha of Colombia. The area now occupied by the republics of Colombia and Panama formed a linguistic and archæological barrier between the great civilisations of Mexico and Peru. In this culture zone the dominant factor is Chibchan; on the other hand, the ancient art of Chiriqui was influenced more by Mexico than by the south, but the Chiriquian culture was distinctively indigenous, and radiated into southern Costa Rica.

Attention is directed throughout the memoir to the general phylogenetic trend in the development of Chiriquian art as a whole. The elegant stone vessels carved in the form of a jaguar are traced back to an oval prototype with a hollow pedestal; with the exception of architecture, the stone art of Chiriqui compares favourably with that of Mexico or Peru. The especial interest of Chiriquian pottery was first emphasised by Prof. W. H. Holmes (Sixth Ann. Rep. Bur. Am. Ethnol., 1888), and Dr. MacCurdy has with slight modifications adopted his classification. The pottery, especially the unpainted ware, is the connecting link between the products of the stone worker and artificer in metal. The "prototype was presumably the calabash. Aside from this, the plant world had practically no influence on the elaboration of form and ornament." The unpainted ware includes the terra-cotta or biscuit group, or, as MacCurdy prefers to call it, the armadillo group, as its ornamentation is mainly based on the armadillo, and three smaller groups.

The painted ware consists of ten groups, of which the fish or tripod, lost colour, alligator, and polychrome groups are the most important (Fig. 1). As might be anticipated, the introduction of colour as a decorative factor often tended to minimise the importance of incised and plastic features; the armadillo and serpent are practically never executed in paint, while incised or plastic motives derived from the alligator are equally rare. Very characteristic of Chiriquian pottery is the presence of three hollow legs, provided with long slits and containing pellets, which serve as a rattle; most of these in the painted ware have a fish ornamentation. The lost colour process was confined to a single, rather large, group of ware; it consisted of tracing the design in wax, the application of a solid coat of black paint over the area to be decorated, and immersing the vessel in hot water, which melted the wax, the design part that was waxed thus showing up light. An analogous method is employed in Java for decorating sarongs.

In the alligator group the designs are always on a pale yellow slip; black and red are the delineating colours. As a matter of fact, it is the crocodile, and not the alligator, which is depicted. The modifications which occur in the form of the crocodile or of parts of it constitute a very pretty

FIG. 1.—Polychrome ware. Vase of eccentric form, the chief ornamental feature being the elaborate branching scroll filling each of the two shoulder panels; the engaged crocodile motives are easily distinguished.

example of the conventionalisation of designs. The highest technical excellence was achieved in the polychrome group; here a purple colour was introduced derived from a non-ferruginous metallic oxide, and not from the *Purpura patula*, which was used to dye cotton thread; it is also characterised by elegant scroll designs derived from crocodiles. The gold Chiriquian figurines are famous, and are here treated adequately for the first time. Squier (1859) says he "was informed by the late Governor of the Bank of England that several thousand pounds' worth were annually remitted from the Isthmus as bullion to that establishment," where they were melted down.

A. C. HADDON.

[1] "A Study of Chiriquian Antiquities." By Prof. G. G. MacCurdy. (Memoirs of the Connecticut Academy of Arts and Sciences, vol. iii., March, 1911.) Pp. xx+249+xlix plates. (New Haven, Conn.: Yale University Press, 1911.)

THE BRITISH ASSOCIATION AT DUNDEE.

ONE of the most successful meetings of the British Association in recent years, and the largest since the Cambridge meeting of 1904, when the total attendance was 2789, in comparison with about 2500 at Dundee, was brought to a close as we went to press last week. A distinguishing and pleasing characteristic of the meeting was the interest taken in scientific questions by the people of Dundee and the neighbourhood; and to this interest may perhaps be attributed the generous provision made privately for visitors.

In proposing a cordial vote of thanks to the Lord Provost, Magistrates, and Town Council of Dundee for this unbounded hospitality, at the closing meeting on September 11, the President, Prof. Schäfer, rightly remarked that though he had attended many meetings of the Association, he did not think that on any occasion had a more cordial welcome been extended than that enjoyed at Dundee. He could certainly say that the Association had never been entertained more royally or hospitably.

Lord Provost Urquhart, in acknowledging the vote of thanks, said that from the time the suggestion was first made by Prof. D'Arcy Thompson that it might be possible to have a visit from the British Association, the citizens had responded most enthusiastically. The providing of hospitality had been a problem owing to the limited hotel accommodation in the city, but the local committee had, he hoped, been able to solve it to the satisfaction of the visitors.

Sir William White, the President-elect, proposed thanks to the Council of University College, the governing bodies of the Chamber of Commerce, Technical College, and other institutions for their kindness in placing their buildings and resources at the disposal of the Association.

Principal Griffiths moved a vote of thanks to the Provost and Magistrates of the burghs of St. Andrews, Dunfermline, and Arbroath, and to all who had contributed by means of excursions, garden-parties, and in other ways to the entertainment of the members. Finally, Prof. Perry, the general treasurer, expressed the thanks of the Association to the local officers and executive for the admirable arrangements they had made, and remarked that it was the best engineered meeting he had attended in forty years.

At the meeting of the General Committee on September 11, the following resolutions submitted by the sections named were adopted:—

Mathematical and Physical Science.—(1) That it be recommended to the General Committee that the cordial thanks of the Association be forwarded to the *Falmouth* Committee for their valuable services since their appointment in 1901; and especially to their chairman, Sir William Preece, and the secretaries, Dr. R. T. Glazebook and Dr. W. N. Shaw.

That, having regard to the importance of the observations at Falmouth in the work of the previous survey and in other work in connection with terrestrial magnetism and meteorology, steps be taken to assist an appeal for a Treasury grant, in order that the observatory at Falmouth may be efficiently maintained.

(2) That it is desirable that a detailed magnetic survey of the British Isles, on the lines of that of Profs. Rucker and Thorpe for the epoch of 1891, should now be repeated, in order to answer the question as to the local variations of the terrestrial magnetic elements within twenty-five years.

That a representation to this effect be made to the Royal Society, the Admiralty, the Ordnance Survey, and the Meteorological Committee.

Zoology.—The British Association for the Advancement of Science deplores the rapid destruction of fauna and flora throughout the world, and regards it as an urgent duty that immediate steps be taken to secure the preservation of all kinds of animals and plants, irrespective of their economic or sporting value.

Anthropology.—That the copies of the fourth edition of "Notes and Queries in Anthropology," now on the point of publication through the committee appointed for the purpose of its preparation, be delivered as heretofore to the Royal Anthropological Institute for sale to its members and to the public, the proceeds to be reserved at the disposal of the Association towards the expenses of any future editions, and accounts of the sales to be submitted to the general treasurer of the Association on demand.

Papers to be printed *in extenso*:—Dr. J. V. Eyre, "Report on Solubility," part ii.; Sir John Macdonald, "The Road Problem."

A sum of 1036*l.* 18*s.* 8*d.* was appropriated for scientific purposes by the committee. Subjoined is a synopsis of the subjects for which the grants are made, and the names of chairmen of the committees:—

Mathematical and Physical Science.

Prof. H. H. Turner, seismological observations ...	£60 0 0	
Dr. W. N. Shaw, upper atmosphere	50 0 0	
Sir W. Ramsay, grant to the International Commission on Physical and Chemical Constants	40 0 0	
Prof. M. J. M. Hill, tabulation of Bessel functions ...	30 0 0	
		£180 0 0

Chemistry.

Dr. W. H. Perkin, study of hydro-aromatic substances	20 0 0	
Prof. H. E. Armstrong, dynamic isomerism ...	30 0 0	
Prof. F. S. Kipping, transformation of aromatic nitroamines	20 0 0	
A. D. Hall, plant enzymes	30 0 0	
		£100 0 0

Geology.

R. H. Tiddeman, erratic blocks	5 0 0	
Prof. W. W. Watts, igneous and associated sedimentary rocks of Glensaul	10 0 0	
Prof. P. F. Kendall, list of characteristic fossils ...	5 0 0	
Dr. J. Horne, Old Red Sandstone of Dura Den ...	75 0 0	
Dr. A. Strachan, Ramsay Island, Pembroke	10 0 0	
Prof. Grenville Cole, Old Red Sandstone of Kiltorcan ...	15 0 0	
		£120 0 0

Zoology.

Prof. S. J. Hickson, table at the Zoological Station at Naples	30 0 0	
Dr. A. E. Shipley, Belmullet Whaling Station	15 0 0	
Dr. Chalmers Mitchell, nomenclator animalium genera et subgenera ...	100 0 0	
		£145 0 0

Engineering.		
Sir W. H. Preece, gaseous explosions	80 0 0	
		£80 0 0
Anthropology.		
Dr. R. Munro, Glastonbury Lake Village	5 0 0	
C. H. Read, age of stone circles	2 2 2	
Dr. R. Munro, artificial islands in Highland lochs	5 0 0	
Prof. G. Elliot Smith, physical character of ancient Egyptians	34 16 6	
Prof. A. Thomson, anthropometric investigations in British Isles	5 0 0	
Prof. W. Ridgeway, Roman sites in Britain	15 0 0	
Prof. W. Ridgeway, excavations in Macedonia	30 0 0	
E. S. Hartland, Hausa manuscripts	20 0 0	
		£116 18 8
Physiology.		
Prof. E. A. Schäfer, the ductless glands	40 0 0	
Prof. S. J. Hickson, table at the Zoological Station at Naples	20 0 0	
Prof. J. S. Macdonald, calorimetric observations	45 0 0	
Prof. Starling, oxy-hæmoglobin	15 0 0	
Prof. F. Gotch, mammalian heart	20 0 0	
		£140 0 0
Botany.		
Dr. D. H. Scott, structure of fossil plants	15 0 0	
Prof. A. C. Seward, Jurassic flora of Yorkshire	15 0 0	
Prof. F. Keeble, flora of peat of Kennet Valley	15 0 0	
A. G. Tansley, vegetation of Ditcham Park	45 0 0	
		£90 0 0
Education.		
Prof. J. J. Findlay, mental and physical factors ...	20 0 0	
Dr. G. A. Auden, influence of school books on eyesight ...	15 0 0	
Sir H. Miers, scholarships, &c., held by University students	5 0 0	
		£40 0 0
Corresponding Societies Committee.		
W. Whitaker, for preparation of report	25 0 0	
		£25 0 0
Total		£1036 18 8

SECTION D.

ZOOLOGY.

OPENING ADDRESS BY P. CHALMERS MITCHELL, D.Sc., F.R.S., PRESIDENT OF THE SECTION.

Zoological Gardens and the Preservation of Fauna.

IN thinking over possible subjects for this Presidential Address, I was strongly tempted to enter on a discussion of the logical methods and concepts that we employ in zoology. The temptation was specially strong to a Scot, speaking in Scotland, that he should devote the hour when the prestige of the presidential chair secured him attention, to putting his audience right on logic and metaphysics. But I reflected that zoology is doing very well, however its logic be wavering, and that as all lines subtend an equal angle at infinity, it would be of small moment if I were to postpone my remarks on metaphysics. And so I am to essay a more modest but a more urgent theme, and ask you to consider the danger that threatens the surviving land-fauna of this globe. A well-known example may serve to remind you how swift is the course of destruction. In 1867, when the British Association last met at Dundee, there were still millions of bison roaming over the prairies and forests of North America. In that year the building of the Union Pacific, the first great trans-continental railway, cut the herd in two. The southern division, consisting itself of several million individuals, was wiped out between 1871 and 1874, and the practical destruction of the northern herd was completed between 1880 and 1884. At present there are only two herds of wild bison in existence. In the Yellowstone Park only about twenty individuals remained in 1911, the greater part of the herd having been killed by poachers. A larger number, more than three hundred, still survive near the Great Slave Lake, and there are probably nearly two thousand in captivity, in various zoological gardens, private domains and State parks. It is only by the deliberate and conscious interference of man that the evil wrought by man has been arrested.

A second example that I may select is also taken from the continent of North America, but it is specially notable because it is sometimes urged, as in India, that migratory birds require no protection. Audubon relates that just a century ago passenger pigeons existed in countless millions, and that for four days at a time the sky was black with the stream of migration. The final extinction of this species has taken place since the last meeting of the Association in Dundee. In 1906 there were actually five single birds living, all of which had been bred in captivity, and I understand that these last survivors of a prolific species are now dead, although the birds ranged in countless numbers over a great continent.

It would be futile to discuss in detail the precise agencies by which the destruction of animal life is wrought, or the pretexts or excuses for them. The most potent factors are the perfection of the modern firearm and the enormous increase in its use by civilised and barbarous man. Sometimes the pretext is sport, sometimes wanton destructiveness rules. The extermination of beasts of prey, the clearing of soil for stock or crops, the securing of meat, the commercial pursuit of hides and horns and of furs and feathers, all play their part. Farmers and settlers on the outskirts of civilisation accuse the natives, and allege that the problem would be solved were no firearms allowed to any but themselves. Sportsmen accuse other sportsmen, whom they declare to be no real sportsmen, and every person whose object is not sport. The great museums, in the name of science, and the rich amateur collectors press forward to secure the last specimens of moribund species.

But even apart from such deliberate and conscious agencies, the near presence of man is inhospitable to wild life. As he spreads over the earth, animals wither before him, driven from their haunts, deprived of their food, perishing from new diseases. It is part of a general biological process. From time to time, in the past history of the world, a species, favoured by some happy kink of structure or fortunate accident of adaptability, has become dominant. It has increased greatly in numbers, outrunning its natal bounds, and has radiated in every possible direction, conquering woodland and prairies, the hills and the plains, transcending barriers that had seemed impassable, and perhaps itself breaking up into new local races and varieties. It must be long since such a triumphant progress was unattended by death and destruction. When the first terrestrial animals crept out of their marshes into the clean air of the dry land, they had only plants and the avenging pressure of physical forces to overcome. But when the Amphibians were beaten by the Reptiles, and when from amongst the Reptiles some insignificant species acquired the prodigious possibility of transformation to Mammals, and still more when amongst the Mammals Eutherian succeeded Marsupial, Carnivore the Creodont, and Man the Ape, it could have been only after a fatal contest that the newcomers triumphed. The struggle, we must suppose, was at first most acute between animals and their nearest inferior allies, as similarity of needs brings about the keenest competition, but it must afterwards have been extended against lower and lower occupants of the coveted territory.

The human race has for long been the dominant terrestrial species, and man has a wider capacity for adaptation to different environments, and an infinitely greater power of transcending geographical barriers than have been enjoyed by any other set of animals. For a considerable time many of the more primitive tribes, especially before the advent of firearms, had settled down into a kind of natural equilibrium with the local mammalian fauna, but these tribes have been first driven to a keener competition with the lower animals, and then, in most parts of the world, have themselves been forced almost or completely out of existence. The resourceful and aggressive higher races have now reached into the remotest parts of the earth and have become the exterminators. It must now be the work of the most intelligent and provident amongst us to arrest this course of destruction, and to preserve what remains.

In Europe, unfortunately, there is little left sufficiently large and important to excite the imagination. There is the European bison, which has been extinct in Western Europe for many centuries, whilst the last was killed in East Prussia in 1755. There remains a herd of about seven hundred in the forests of Lithuania, strictly protected by the Tsar, whilst there are truly wild animals, in considerable numbers, in the Caucasus, small captive herds on the private estates of the Tsar, the Duke of Pless and Count Potocki, and a few individuals in various zoological gardens. There is the beaver, formerly widespread in Europe, now one of the rarest of living mammals, and lingering in minute numbers in the Rhone, the Danube, in a few Russian rivers, and in protected areas in Scandinavia. The wolf and the bear have shrunk to the recesses of thick forests and the remotest mountains, gluttons to the most barren regions of the north. The chamois survives by favour of game-laws and the vast inaccessible areas to which it can retreat, but the mouflon of Corsica and Sardinia and the ibex in Spain are on the verge of extinction. Every little creature, from the otter, wild cat, and marten to the curious desman, is disappearing.

India contains the richest, the most varied, and, from many points of view, the most interesting part of the Asiatic fauna. Notwithstanding the teeming human population it has supported from time immemorial, the extent of its area, its dense forests and jungles, its magnificent series of river valleys, mountains, and hills have preserved until recent times a fauna rich in individuals and species. The most casual glance at the volumes by sportsmen and naturalists written forty or fifty years ago reveals the delight and wonder of travel in India so comparatively recently as the time when the Association last met in Dundee. Sir H. H. Johnston has borne witness that even in 1895 a journey "through almost any part of India was of absorbing interest to the naturalist." All is changed now, and there seems little doubt but that the devastation in the wonderful mammalian fauna has been wrought chiefly by British military officers and civilians, partly directly, and partly by their encouragement of the sporting instincts of the Mohammedan population and the native regiments, although the clearing of forests and the draining of marshlands have played an important contributory part. The tiger has no chance against the modern rifle. The one-horned rhinoceros has been nearly exterminated in Northern India and Assam. The magnificent gaur, one of the most splendid of living creatures, has been almost killed off throughout the limits of its range—southern Indian and the Malay Peninsula. Bears and wolves, wild dogs and leopards are persecuted remorselessly. Deer and antelope have been reduced to numbers that alarm even the most thoughtless sportsmen, and wild sheep and goats are being driven to the utmost limits of their range.

When I speak of the fauna of Africa, I am always being reminded of the huge and pathless areas of the Dark Continent, and assured that lions and leopards, elephants and giraffe still exist in countless numbers, nor do I forget the dim recesses of the tropical forests where creatures still lurk of which we have only the vaguest rumour. But we know that South Africa, less than fifty years ago, was a dream that surpassed the imagination of the most ardent hunter. And we know what it is now. It is traversed by railways, it has been rolled over by the devastations of war. The game that once covered the land in unnumbered millions is now either extinct, like the quagga and the black wildebeeste, or its scanty remnant lingers in a few reserves and on a few farms. The sportsman and the hunter have been driven to other parts of the continent, and I have no confidence in the future of the African fauna. The Mountains of the Moon are within range of a long vacation holiday. Civilisation is eating into the land from every side. All the great European countries are developing their African possessions. There are exploring expeditions, punitive expeditions, shooting and collecting expeditions. Railways are being pushed inland, water-routes opened up. The land is being patrolled and policed and taxed, and the wild animals are suffering. Let us go back for a moment to the Transvaal and consider what has happened since the Rand was opened, neglecting the reserves. Lions are nearly extinct. The hyæna has been trapped and shot and poisoned out of existence. The eland is extinct. The giraffe is extinct. The elephant is extinct. The rhinoceros is extinct. The buffalo is extinct. The bontebok, the red hartebeeste, the mountain zebra, the oribi, and the grysbok are so rare as to be practically extinct. And the same fate may at any time overtake the rest of Africa. The white man has learned to live in the tropics; he is mastering tropical diseases; he has need of the vegetable and mineral wealth that lie awaiting him, and although there is yet time to save the African fauna, it is in imminent peril.

When we turn to Australia, with its fauna of unique zoological interest, we come to a more advanced case of the same disease. In 1909 Mr. G. C. Shortridge, a very skilled collector, working for the British Museum, published in the Proceedings of the Zoological Society of London the results of an investigation he had carried out on the fauna of Western Australia south of the tropics, during the years 1904–7.

He gave a map showing the present and comparatively recent distribution for each of the species of Marsupials and Monotremes indigenous to that locality. West Australia as yet has been very much less affected by civilisation than Queensland, New South Wales, or Victoria, and yet in practically every case there was found evidence of an enormous recent restriction of the range of the species. Marsupials and Monotremes are, as you know, rather stupid animals, with small powers of adaptation to new conditions, and they are in the very gravest danger of complete extinction. In the island of Tasmania, the thylacine, or marsupial wolf, and the Tasmanian devil have unfortunately incurred the just hostility of the stock raiser and poultry farmer, and the date of their final extermination is approaching at a pace that must be reckoned by months rather than by years.

The development of the continent of North America has been one of the wonders of the history of the world, and we on this side of the Atlantic almost hold our breath as we try to realise the material wealth and splendour and the ardent intellectual and social progress that have turned the United States into an imperial nation. But we know what has happened to the American bison. We know the danger that threatens the pronghorn, one of the most isolated and interesting of living creatures, the Virginian deer, the mule-deer, and the bighorn sheep. Even in the wide recesses of Canada, the bighorn, the caribou, the elk, the wapiti, the white mountain goat, and the bears are being rapidly driven back by advancing civilisation. In South America less immediate danger seems to threaten the jaguar and maned wolf, the tapirs and ant-eaters and sloths, but the energy of the rejuvenated Latin races points to a huge encroachment of civilisation on wild nature at no distant date.

You will understand that I am giving examples and not a catalogue even of threatened terrestrial mammals. I have said nothing of the aquatic carnivores, nothing of birds, or of reptiles, or of batrachians and fishes. And to us who are zoologists, the vast destruction of invertebrate life, the sweeping out, as forests are cleared and the soil tilled, of innumerable species that are not even named or described is a real calamity. I do not wish to appeal to sentiment. Man is worth many sparrows; he is worth all the animal population of the globe, and if there were not room for both, the animals must go. I will pass no judgment on those who find the keenest pleasure of life in gratifying the primeval instinct of sport. I will admit that there is no better destiny for the lovely plumes of a rare bird than to enhance the beauty of a beautiful woman. I will accept the plea of those who prefer a well-established trinomial to a moribund species. But I do not admit the right of the present generation to careless indifference or to wanton destruction. Each generation is the guardian of the existing resources of the world; it has come into a great inheritance, but only as a trustee. We are learning to preserve the relics of early civilisations, and the rude remains of man's primitive arts and crafts. Every civilised nation spends great sums on painting and sculpture, on libraries and museums. Living animals are of older lineage, more perfect craftsmanship and greater beauty than any of the creations of man. And although we value the work of our forefathers, we do not doubt but that the generations yet unborn will produce their own artists and writers, who may equal or surpass the artists and writers of the past. But there is no resurrection or recovery of an extinct species, and it is not merely that here and there one species out of many is threatened, but that whole genera, families, and orders are in danger.

Now let me turn to what is being done and what has been done for the preservation of fauna. I must begin by saying, and this was one of the principal reasons for selecting the subject of my address, that we who are professional zoologists, systematists, anatomists, embryologists, and students of general biological problems, in this country at least, have not taken a sufficiently active part in the preservation of the realm of nature that provides the reason for our existence. The first and most practical step of world-wide importance was taken by a former president of the British Association, the late Lord Salisbury, one of the few in the long roll of English statesmen whose mind was attuned to science. In 1899 he arranged for a convention of the Great Powers interested in Africa to consider the preservation of what were curiously described as the "Wild Animals, Birds and Fish" of that continent. The convention, which did most important pioneer work, included amongst its members another president of this Association, Sir Ray Lankester, whom we hold in high honour in this section as the living zoologist who has taken the widest interest in every branch of zoology. But it was confined in its scope to creatures of economic or of sporting value. And from that time on the central authorities of the Great Powers and the local administrators, particularly in the case of tropical possessions, seem to have been influenced in the framing of their rules and regulations chiefly by the idea of preserving valuable game animals. Defining the number of each kind of game that can be killed, charging comparatively high sums for shooting-permits, and the establishment of temporary or permanent reserved tracts in which the game may recuperate, have been the principal methods selected. On these lines, narrow although they are, much valuable work has been done, and the parts of the world where unrestricted shooting is still possible are rapidly being limited. I may take the proposed new Game Act of our Indian Empire, which has recently been explained, and to a certain extent criticised, in the Proceedings of the Zoological Society of London, by Mr. E. P. Stebbing, an enlightened sportsman-naturalist, as an example of the efforts that are being made in this direction, and of their limitations.

The Act is to apply to all India, but much initiative is left to local governments as to the definition of the important words "game" and "large animal." The Act, however, declares what the words are to mean in the absence of such local definitions, and it is a fair assumption that local interpretations will not depart widely from the lead given by the central authority. Game is to include the following in their wild state:—Pigeons, sandgrouse, peafowl, junglefowl, pheasants, partridges, quail, spurfowl, florican and their congeners; geese, ducks and their congeners; woodcock and snipe. So much for birds. Mammals include hares and "large animals" defined as "all kinds of rhinoceros, buffalo, bison, oxen; all kinds of sheep, goats, antelopes and their congeners; all kinds of gazelle and deer."

The Act does not affect the pursuit, capture, or killing of game by non-commissioned officers or soldiers on whose behalf regulations have been made, or of any animal for which a reward may be claimed from Government, of any large animal in self-defence, or of any large animal by a cultivator or his servants, whose crops it is injuring. Nor does it affect anything done under licence for possessing arms and ammunition to protect crops, or for destroying dangerous animals, under the Indian Arms Act. Then follow prohibitory provisions, all of which refer to the killing or to the sale or possession of game or fish, and provisions as to licences for sportsmen, the sums to be paid for which are merely nominal, but which carry restrictions as to the number of head that may be killed. I need not enter upon detailed criticism as to the vagueness of this Act from the zoological point of view, or as to the very large loopholes which its provisions leave to civil and military sportsmen; these have been excellently set forth by Mr. Stebbing, who has full knowledge of the special conditions which exist in India. What I desire to point out is that it conceives of animals as game rather than as animals, and that it does not even contemplate the possibility of the protection of birds of prey and beasts of prey, and still less of the enormous number of species of animals that have no sporting or economic value.

Mr. Stebbing's article also gives a list of the very large number of reserved areas in India which are described as "Game Sanctuaries." His explanation of them is as follows:—"With a view to affording a certain protection to animals of this kind (the elephant, rhinoceros, ruminants, &c.), and of giving a rest to species which have been heavily thinned in a district by indiscriminate shooting in the past, or by anthrax, drought, &c., the idea of the Game Sanctuary was introduced into India (and into other parts of the world) and has been accepted in many parts of the country. The sanctuary consists of a block of country, either of forest or of grassland, &c., depending on the nature of the animal to which sanctuary is required to be given; the area has rough boundaries such as roads, fire lines, nullahs, &c., assigned to it, and no shooting of any kind is allowed in it, if it is a sanctuary pure and simple; or the shooting of carnivora may be permitted, or of these latter and of everything else save certain specified animals."

Mr. Stebbing goes on to say that sanctuaries may be formed in two ways. The area may be automatically closed and reopened for certain definite periods of years, or be closed until the head of game has become satisfactory, the shooting on the area being then regulated, and no further closing taking place, save for exceptional circumstances. The number of such sanctuary blocks, both in British India and in the Native States, will cause surprise and pleasure to most readers, and it cannot be doubted but that they will have a large effect on the preservation of wild life. The point, however, that I wish to make is that in the minds of those who have framed the Game Act, and of those who have caused the making of the sanctuaries—as indeed in the minds of their most competent critics—the dominant idea has been the husbanding of game animals, the securing for the future of sport for sportsmen. I do not forget that there is individual protection for certain animals; no elephant, except a rogue elephant, may be shot in India, and there are excellent regulations regarding birds with plumage of economic value. The fact remains that India, a country which still contains a considerable remnant of one of the richest faunas of the world, and which also is probably more efficiently under the autocratic control of a highly educated body of permanent officials, central and local, than any other country in the world, has no provision for the protection of its fauna simply as animals.

The conditions in Africa are very different from those in India. The land is portioned out amongst many Powers. The settled population is much less dense, and the hold of the white settler and the white ruler is much less complete. The possibility of effective control of native hunters and of European travellers and sportsmen is much smaller, and as there are fewer sources of revenue, the temptation to exploit the game for the immediate development of the struggling colonies is much greater. Still, the lesson of the extinction of the South African fauna is being taken to heart. I have had the opportunity of going through the regulations made for the shooting of wild animals in Africa by this country, by our autonomic colonies, by France, Germany, Italy, Portugal, and Belgium, and, with the limitation that they are directed almost solely towards the protection of animals that can be regarded as game, they afford great promise for the future. But this limitation is still stamped upon them, and even so enthusiastic a naturalist as Major Stevenson-Hamilton, the warden of the Transvaal Government Game Reserves, who has advocated the substitution of the camera for the rifle, appears to be of the opinion that the platform of the convention of 1900 is sufficient. It included the sparing of females and immature animals, the establishment of close seasons and game sanctuaries, the absolute protection of rare species, restrictions on the export for trading purposes of skins, horns, and tusks, and the prohibition of pits, snares, and game traps. Certainly the rulers of Africa are seeing to the establishment of game reserves. As for British Africa, there are two in Somaliland, two in the Sudan, two in Uganda, and two in British East Africa (with separate reserves for eland, rhinoceros, and hippopotamus), two in Nyasaland, three in the Transvaal, seven in Rhodesia, several in Natal and in Cape Colony, and at least four in Nigeria. These are now administered by competent officials, who, in addition, are usually the executive officers of the game laws outside the reserved territory. Here again, however, the preservation of game animals and of other animals of economic value, and of a few named species, is the fundamental idea. In 1909 I had the honour of being a member of a deputation to the Secretary of State for the Colonies, arranged by the Society for the Preservation of the Wild Fauna of the Empire, one of the most active and successful bodies engaged in arousing public opinion on the subject. Among the questions on which we were approaching Lord Crewe was that of changes in the locality of reserves. Sometimes it had happened that for the convenience of settlers or because of railway extension, or for some other reason, proposals were made to open or clear the whole or part of a reserve. When I suggested that the substitution of one piece of ground for another, even of equivalent area, might be satisfactory from the point of view of the preservation of large animals, but was not satisfactory from the zoological point of view, that in fact pieces of primeval land and primeval forest contained many small animals of different kinds which would be exterminated once and for all when the land was brought under cultivation, the point was obviously new not only to the Colonial Secretary, who very courteously noted it, but to my colleagues.

This brings me to the general conclusion to which I wish to direct your attention, and for which I hope to engage your sympathy. We may safely leave the preservation of game animals, or rare species if these are well known and interesting, and of animals of economic value, to the awakened responsibility and the practical sense of the governing powers, stimulated as these are by the enthusiasm of special societies. Game laws, reserves where game may recuperate, close seasons, occasional prohibition and the real supervision of licence-holders are all doing their work effectively. But there remains something else to do, something which I think should interest zoologists particularly, and on which we should lead opinion. There exist in all the great continents large tracts almost empty of resident population, which still contain vegetation almost undisturbed by the ravages of man, and which still harbour a multitude of small animals, and could afford space for the larger and better-known animals. These tracts have not yet been brought under cultivation, and are rarely traversed except by the sportsman, the explorer, and the prospector. On these there should be established, in all the characteristic faunistic areas, reservations which should not be merely temporary recuperating grounds for harassed game, but absolute sanctuaries. Under no condition should they be open to the sportsman. No gun should be fired, no animal slaughtered or captured save by the direct authority of the wardens of the sanctuaries, and for the direct advantage of the denizens of the sanctuaries, for the removal of noxious individuals, the controlling of species that were increasing beyond reason, the extirpation of diseased or unhealthy animals. The obvious examples are not the game reserves of the Old World, but the national parks of the New World and of Australasia. In the United States, for instance, there are now the Yellowstone National Park with more than two million acres, the Yosemite in California with nearly a million acres, the Grand Cañon Game Preserve with two million acres, the Mount Olympus National Monument in Washington with more than half a million acres, and the Superior Game and Forest Preserve with nearly a million acres, as well as a number of smaller reserves for special purposes, and a chain of coastal areas all round the shores for the preservation of birds. In Canada, in Alberta, there are the Rocky Mountains Park, the Yoho Park, Glacier Park, and Jasper Park, together extending to more than nine million acres, whilst in British Columbia there are smaller sanctuaries. These, so far as laws can make them, are inalienable and inviolable sanctuaries for wild animals. We ought to have similar sanctuaries in every country of the world, national parks secured for all time against all the changes and chances of the nations by international agreement. In the older and more settled countries the areas selected unfortunately must be determined by various considerations, of which faunistic value cannot be the most important. But certainly in Africa, and in large parts of Asia, it would still be possible that they should be selected in the first place for their faunistic value. The scheme for them should be drawn up by an international commission of experts in the geographical distribution of animals, and the winter and summer haunts of migratory birds should be taken into consideration. It is for zoologists to lead the way, by laying down what is required to preserve for all time the most representative and most complete series of surviving species without any reference to the extrinsic value of the animals. And it then will be the duty of the nations, jointly and severally, to arrange that the requirements laid down by the experts shall be complied with.

And now I come to the last side of my subject, that of zoological gardens, with which I have been specially connected in the last ten years. My friend M. Gustave Loisel, in his recently issued monumental "Histoire des Ménageries," has shown that in the oldest civilisations of which we have record, thousands of years before the Christian era, wild animals were kept in captivity. He is inclined to trace the origin of the custom to a kind of totemism. Amongst the ancient Egyptians, for instance, besides the bull and the serpent, baboons, hippopotami, cats, lions, wolves, ichneumons, shrews, wild goats, and wild sheep, and of lower animals, crocodiles, various fishes, and beetles were held sacred in different towns. These animals were protected, and even the involuntary killing of any of them was punished by the death of the slayer, but besides this general protection, the priests selected individuals which they recognised by infallible signs as being the divine animals, and tamed, guarded, and fed in the sacred buildings, whilst the revenues derived from certain tracts of land were set apart for their support. The Egyptians were also famous hunters, and kept and tamed various wild animals, including cheetahs, striped hyænas, leopards, and even lions, which they used in stalking their prey. The tame lions were sometimes clipped, as in ancient Assyria, and used both in the chase and in war. The rich Egyptians of Memphis had large parks in which they kept not only the domestic animals we now know, but troops of gazelles, antelopes, and cranes, which were certainly tame and were herded by keepers with wands. So also in China at least fifteen centuries before our era, wild animals were captured in the far north by the orders of the Emperor and were kept in the royal parks. A few centuries later the Emperor Wen-Wang established a zoological collection between Pekin and Nankin, his design being partly educational, as it was called the Park of Intelligence. In the valley of the Euphrates, centuries before the time of Moses, there were lists of sacred animals, and records of the keeping in captivity of apes, elephants, rhinoceroses, camels and dromedaries, gazelles and antelopes, and it may well be that the legend of the Garden of Eden is a memory of the royal menagerie of some ancient king. The Greeks, whose richest men had none of the wealth of the Egyptians or of the princes of the East, do not appear to have kept many wild animals, but the magnates of imperial Rome captured large numbers of leopards, lions, bears, elephants, antelopes, giraffes, camels, rhinoceroses and hippopotami, and ostriches and crocodiles, and kept them in captivity, partly for use in the arena, and partly as a display of the pomp and power of wealth. In later times royal persons and territorial nobles frequently kept menageries of wild animals, aviaries and aquaria, but all these have long since vanished.

Thus, although the taste for keeping wild animals in captivity dates from the remotest antiquity, all the modern collections are of comparatively recent origin, the oldest being the Imperial Menagerie of the palace of Schönbrunn, Vienna, which was founded about 1752, whilst some of the most important are only a few years old. These existing collections are of two kinds. A few are the private property of wealthy landowners, and their public importance is due partly to the opportunity they have afforded for experiments in acclimatisation on an extensive scale, and still more to the refuge they have given to the relics of decaying species. The European bison is one of the best-known cases of such preservation, but a still more extraordinary instance is that of Père David's deer, a curious and isolated type which was known only in captivity in the imperial parks of China. The last examples in China were killed in the Boxer war, and the species would be absolutely extinct but for the small herd maintained by the Duke of Bedford at Woburn Abbey. In 1909 this herd consisted of only twenty-eight individuals; it now numbers sixty-seven. The second and best-known types of collections of living animals are in the public zoological gardens and parks maintained by societies, private companies, States and municipalities. There are now more than a hundred of these in existence, of which twenty-eight are in the United States, twenty in the German Empire, five in England, one in Ireland, and none in Scotland. But perhaps I may be allowed to say how much I hope that the efforts of the Zoological Society of Scotland will be successful, and that before many months are over there will be a zoological park in the capital of Scotland. There is no reason of situation or of climate which can be urged against it. The smoke and fog of London are much more baleful to animals than the east winds of Edinburgh. The gardens of North Germany and the excellent institution at Copenhagen have to endure winters much more severe than those of lowland Scotland, whilst the arctic winter and tropical summer of New York form a peculiarly unfortunate combination, and none the less the Bronx Park at New York is one of the most delightful menageries in existence. The Zoological Society of Scotland will have the great advantage of beginning where other institutions have left off; it will be able to profit by the experience and avoid the mistakes of others. The Zoological Society of London would welcome the establishment of a menagerie in Scotland, for scientific and practical reasons. As I am speaking in Scotland, I may mention two of the practical reasons. The first is that in Great Britain we labour under a serious disadvantage as compared with Germany with regard to the importation of rare animals. When a dealer in the tropics has rare animals to dispose of, he must send them to the best market, for dealing in wild animals is a risky branch of commerce. If he send them to this country, there are very few possible buyers, and it often happens that he is unable to find a purchaser. If he send them to Germany, one or other of the twenty gardens is almost certain to absorb them, and, failing Germany, Belgium and Holland are near at hand. Were there twenty prosperous zoological gardens in Great Britain, they could be better stocked, at cheaper rates, than those we have now. The second practical reason is that it is a great advantage to menageries to have easy opportunities of lending and exchanging animals; for it often happens that as a result of successful breeding or of gifts on one hand, or of deaths on the other, a particular institution is overstocked with one species or deficient in another.

One of the ideas strongly in the minds of those who founded the earlier of modern zoological gardens was the introduction and acclimatisation of exotic animals that might have an economic value. It is curious how completely this idea has been abandoned and how infertile it has proved. The living world would seem to offer an almost unlimited range of creatures which might be turned to the profit of man and as domesticated animals supply some of his wants. And yet I do not know of any important addition to domesticated animals since the remotest antiquity. A few birds for the coverts, fancy water-fowl for ponds and lakes, and brightly plumaged birds for cages or for aviaries have been introduced, chiefly through zoological societies, but we must seek other reasons for their existence than these exiguous gains.

Menageries are useful in the first place as educational institutions, in the widest sense of the word. Every new generation should have an opportunity of seeing the wonder and variety of animated nature, and of learning something that they cannot acquire from books or pictures or lectures about the chief types of wild animals. For that reason zoological gardens should be associated in some form with elementary and secondary education. We in London admit the children from elementary schools on five mornings in the week at the nominal charge of a penny for each child, and in co-operation with the Educational Committee of the London County Council, we conduct courses of lectures and demonstrations for the teachers, who will afterwards bring their children to visit the gardens.

Menageries provide one of the best schools for students of art, for nowhere else than amongst living animals are to be found such strange fantasies of colour, such play of light on contour and surface, such intricate and beautiful harmonies of function and structure. To encourage art the London society allows students of recognised schools of drawing and painting, modelling and designing, to use the gardens at nominal rates.

Menageries provide a rich material for the anatomist, histologist, physiologist, parasitologist, and pathologist. It is surprising to note how many of the animals used by Lamarck and Cuvier, Johannes Müller and Wiedersheim, Owen and Huxley, were obtained from zoological gardens. At all the more important gardens increasing use is being made of the material for the older purposes of anatomical research and for the newer purposes of pathology and physiology.

There remains the fundamental reason for the existence of menageries, that they are collections of living animals, and therefore an essential material for the study of zoology. Systematic zoology, comparative anatomy, and even morphology, the latter the most fascinating of all the attempts of the human intellect to recreate nature within the categories of the human mind, have their reason and their justification in the existence of living animals under conditions in which we can observe them. And this leads me to a remark which ought to be a truism, but which, unfortunately, is still far from being a truism. The essential difference between a zoological museum and a menagerie is that in the latter the animals are alive. The former takes its value from its completeness, from the number of rare species of which it has examples, and from the extent to which its collections are properly classified and arranged. The value of a menagerie is not its zoological completeness, not the number of rare animals that at any moment it may contain, not even the extent to which it is duly labelled and systematically arranged, but the success with which it displays its inhabitants as living creatures under conditions in which they can exercise at least some of their vital activities.

The old ideal of a long series of dens or cages in which representatives of kindred species could mope opposite their labels is surely but slowly disappearing. It is a museum arrangement, and not an arrangement for living animals. The old ideal by which the energy and the funds of a menagerie were devoted in the first place to obtaining species "new to the collection" or "new to science" is surely but slowly disappearing. It is the instinct of a collector, the craving of a systematist, but is misplaced in those who have the charge of living animals. Certainly we like to have many species, to have rare species, and even to have new species represented in our menageries. But what we are learning to like most of all is to have the examples of the species we possess, whether these be new or old, housed in such a way that they can live long, and live happily, and live under conditions in which their natural habits, instincts, movements, and routine of life can be studied by the naturalist and enjoyed by the lover of animals.

Slowly the new conditions are creeping in, most slowly in the older institutions hampered by lack of space, cumbered with old and costly buildings, oppressed by the habits of long years and the traditions established by men who none the less are justly famous in the history of zoological science. Space, open air, scrupulous attention to hygiene and diet, the provision of some attempt at natural environment are receiving attention that they have never received before. You will see the signs of the change in Washington and New York, in London and Berlin, in Antwerp and Rotterdam, and in all the gardens of Germany. It was begun simultaneously, or at least independently, in many places and under the inspiration of many men. It is, I think, part of a general process in which civilised man is replacing the old hard curiosity about nature by an attempt at sympathetic comprehension. We no longer think of ourselves as alien from the rest of nature, using our lordship over it for our own advantage; we recognise ourselves as part of nature, and by acknowledging our kinship we are on the surest road to an intelligent mastery. But I must mention one name, that of Carl Hagenbeck, of Hamburg, to be held in high honour by all zoologists and naturalists, although he was not the pioneer, for the open-air treatment and rational display of wild animals in captivity were being begun in many parts of the world while the Thier-Park at Stellingen was still a suburban waste. He has brought a reckless enthusiasm, a vast practical knowledge, and a sympathetic imagination to bear on the treatment of living animals, and it would be equally ungenerous and foolish to fail to recognise the widespread and beneficent influence of his example.

However we improve the older menageries and however numerous and well-arranged the new menageries may be, they must always fall short of the conditions of nature, and here I find another reason for the making of zoological sanctuaries throughout the world. If these be devised for the preservation of animals, not merely for the recuperation of game, if they be kept sacred from gun or rifle, they will become the real zoological gardens of the future, in which our children and our children's children will have the opportunity of studying wild animals under natural conditions. I myself have so great a belief in the capacity of wild animals for learning to have confidence in man, or rather for losing the fear of him that they have been forced to acquire, that I think that man, innocent of the intent to kill, will be able to penetrate fearlessly into the sanctuaries, with camera and notebook and field-glass. In any event, all that the guardians of the future will have to do will be to reverse the conditions of our existing menageries and to provide secure enclosures for the visitors instead of for the animals.

I must end as I began this address, by pleading the urgency of the questions I have been submitting to you as an excuse for diverting your attention to a branch of zoology which is alien from the ordinary avocations of most zoologists, but which none the less is entitled to their fullest support. Again let me say to you that I do not wish to appeal to sentiment; I am of the old school, and, believing that animals are subject and inferior to man, I set no limits to human usufruct of the animal kingdom. But we are zoologists here, and zoology is the science of the living thing. We must use all avenues to knowledge of life, studying the range of form in systematic museums, form itself in laboratories, and the living animal in sanctuaries and menageries. And we must keep all avenues to knowledge open for our successors, as we cannot guess what questions they may have to put to nature.

SECTION E.

GEOGRAPHY.

FROM THE OPENING ADDRESS BY COLONEL SIR C. M. WATSON, K.C.M.G., C.B., PRESIDENT OF THE SECTION.

LEAVING the Sudan,[1] I would like to allude to a very important geographical undertaking which has made considerable progress during the past year. This is the production of the international map of the world on the scale of 1/1000000, a project which has been under the consideration of the leading geographers of the important countries for more than twenty years, since it was first proposed at the International Geographical Congress held at Berne in 1891. The question was discussed at succeeding geographical congresses, but did not take definite shape until the meeting held at Geneva in 1908, when a series of resolutions dealing with the subject were drawn up by a committee composed of distinguished men of many nations, which was appointed to formulate rules for the production of the maps, so as to ensure that they should be prepared upon a uniform system.

These resolutions were approved at a general meeting of the Geneva Congress, and were forwarded by the Swiss Government to the British Government for consideration, whereupon the latter issued invitations to the Governments of Austria-Hungary, France, Germany, Japan, Russia, Italy, Spain, and the United States of North America, asking them to nominate delegates to act as the members of an international committee to meet in London and debate the question. The committee assembled at the Foreign Office in November, 1909, and Colonel S. C. N. Grant, C.M.G., then Director-General of the British Ordnance Survey, was appointed president. The proceedings were opened by the Under-Secretary of State for Foreign Affairs, Sir Charles Hardinge, G.C.M.G., now Lord Hardinge, who, in his address, referred to the progress that had already been made with regard to the international map, and expressed the hope, on behalf of the British Government, that the great undertaking might be brought to a satisfactory conclusion.

The main business before the committee was to settle on the mode of execution of the map, especially as regards the size of the sheets, so as to ensure that adjacent sheets, published by different countries, should fit together; and also to settle upon the symbols, printing, and conventional signs to be used, in order that these should be uniform throughout. A series of resolutions, embodying the decisions arrived at concerning these various points, was approved and drawn up in English, French, and German, the first of these languages being taken as the authoritative text. As the map was to embrace the whole surface of the globe, the method of projection to be adopted was, of course, a very important consideration, and, after due deliberation, it was decided that a modified polyconic projection, with the meridians shown as straight lines, and with each sheet plotted independently on its central meridian, would prove the most satisfactory.

The surface of the sphere was divided into zones, each containing four degrees of latitude, commencing at the equator, and extending to 88° North and 88° South latitude. There were thus twenty-four zones on each side of the equator, and these were distinguished by the letters A to V north, and A to V south. This fixed the height of each sheet. For the width of the sheets, the surface of the sphere was divided into sixty segments, each containing six degrees of longitude, and numbered consecutively from one to sixty, commencing at longitude 180°. This arrangement made each sheet contain six degrees of longitude by four degrees of latitude; but, as the width of the sheets diminished as they approached the poles, it was decided that, beyond 60° North, or 60° South, two or more sheets could be combined. Each sheet could thus be given a clear identification number defining its position on the surface of the globe, without it being necessary to mention the country included in it, or the latitude and longitude. For example, the sheet containing the central part of England is called North, N 30.

In order to ensure that the execution of all the maps should be identical, a scheme of lettering and of conventional topographical signs was drawn up and attached to the resolutions; and it was decided that a scale of kilometres should be shown on each sheet, and also a scale of the national measure of length of the country concerned. As regards the representa-

[1] The main part of the address dealt with the geography of the Sudan and some important points in its history.

tions of altitude it was arranged that contours should be shown at vertical intervals of a hundred metres, or at smaller intervals in the case of very flat, and larger in the case of steep ground, the height being measured from mean sea-level, as determined in the case of each country; while the levels of the surface of the country were to be indicated by a scale of colour tints, the colours being green from 0 to 300 metres, brown from 300 to 2500 metres, and purple above 2500 metres. In the same manner the depths of the ocean and of large lakes were to be indicated by varying tints of blue, so as to show intervals of 100 metres. In order to ensure uniformity in the scale of colours to be used, a copy of it, as approved by the committee, was included in the plate of topographical symbols.

The whole scheme was thoroughly well worked out, and great credit is due to the members of the international committee for the manner in which they carried out their difficult task. Since the meeting of the committee in 1909 the preparation of the sheets, in accordance with the principles decided upon, has been taken in hand in several countries, and a number of these have been issued, which give a good idea of what this great map, the largest ever contemplated, will be like. These sheets deserve to be carefully studied, and will doubtless be the subject of considerable criticism, as there are several points which seem worthy of examination.

In the first place, it is for consideration whether it would not have been better if the colour scheme for representing differences of altitude had been omitted, as it is doubtful whether the advantage of the result gained is commensurate with the increased cost of printing the colours. And one naturally asks for what purpose is the map intended. Is it for the use of skilled geographers, of whom there are a comparatively small number in each country, or is it for the instruction of ordinary people? If it is for the latter, it is to be feared that the colour scheme will give rise to erroneous impressions. Compare, for example, sheet North, M 31, of France, with sheet South, H 34, of part of South Africa. In the former, as the greater part of the country shown is less than 300 metres above the sea, the general colour of the sheet is green, while in the latter, as nearly the whole of the country included has an altitude of more than 300 metres, the map is for the most part brown. This to the less educated man will probably convey the idea that, while France is a fertile country, South Africa is a desert. The fact, too, that the darker tint of green represents the lower level and the lighter the higher, while, in the case of the brown, the lighter represents the lower and the darker the higher, and, in the case of the purple, the relative strength of the tints is again reversed, is rather confusing.

There is another point as regards the colour scheme which might be noticed, that is, that it is not the same on different sheets. For example, the scale of tints adopted in sheet North, O 30 (Scotland), North, M 31 (France), and North, K 35 (Turkey), do not correspond. In the Scotch map the brown colour commences at an altitude of 200 metres, in the French at 300 metres, and in the Turkish at 400 metres. There may be some reason for this, but it appears not to be in accord with the resolutions of the committee. Another reason for omitting the colour scheme for altitudes is that it might be better to keep colour work for other purposes, such as indicating political divisions, as there can be little doubt that so good a map as this, when completed, will be largely used for many purposes. It might be better that on a map of this small scale only the horizontal features, such as coast lines, river courses, railways, roads, and the position of towns should be shown, while to represent height graphically tends to obscure the former.

Another criticism I would venture to make is that the resolutions of the committee appear to have been drawn up on the supposition that the whole world has been accurately surveyed, and no attempt seems to have been made to distinguish between those regions of which the maps are based on triangulation, such as England and parts of Europe, and the countries of which complete surveys have not yet been made. As the construction of the map proceeds and sheets are prepared of parts of the world our knowledge of which is imperfect, this want will become more pressing, but it is noticeable even with regard to the sheets already published. It is one of the evils of cartography that where anything is shown on a carefully engraved map it comes to be regarded as true, and, if it afterwards turns out to be erroneous, it is not easy to get it altered.

The scale of the map, 1/1000000, appears to have been wisely chosen, as it is sufficiently large to give an adequate amount of detail, while, at the same time, the sheets will not be unduly numerous. Of course, for an international map a cadastral scale was essential, although for national maps a scale based upon the national system of measures is more convenient, as, for example, in the United Kingdom, where the scale of one inch and six inches to the mile are better than scales of 1/50000 and 1/10000 would have been. They are more suited for the majority of individuals, and an ordinary foot-rule can be used for measuring distances, instead of having to take them off with a pair of dividers from the printed scale on the map.

Looked at from the general point of view, there can be no doubt that the international map is a most important and valuable undertaking. It is satisfactory that such a leading part in the matter has been taken by the British officers of the Royal Engineers and by the Royal Geographical Society.

In speaking of this map, I have referred to the advisability, if not the necessity, of distinguishing between what is accurately and what is inaccurately known, and this brings me to another matter of considerable interest, the preparation of maps based upon the observations and information collected by explorers in unknown or little known countries. To these explorers, some of whom have not been trained in geographical science, a large amount of detail shown upon modern maps is due, and it is only a small proportion of the land surface of the globe that has, up to the present, been surveyed in a scientific manner.

It is therefore of the greatest importance that the best value possible should be obtained from the work done by explorers, and this in the past has not always been sufficiently attended to, though during the last few years it is better understood. The people who stop at home in comfortable ease do not sufficiently realise the difficulties under which the conscientious traveller works and gathers together information about the country he passes through. Formerly, he generally had to work out his own observations and compile his own maps, but now conditions in this respect have greatly improved, and when he brings home his observations, notes, and sketches he can hand them over to some body, such as the Royal Geographical Society, by whom they will be put in shape in a better manner than he could do it for himself. One has heard of an explorer in a little-known country sitting up all night after a hard day's work, working out his astronomical observations, and trying to put his rough surveys into shape. He would have done better to have gone to sleep and prepared himself by a good rest for the next day's journey. In fact, it would be better if an explorer never looked at the figures of an observation after he had recorded them, or read over the notes of his past work, confining himself to recording what he has actually seen day by day as accurately as circumstances permitted, and carefully distinguishing what he really saw from what he thought he had seen, or what he had heard.

It would be easy to adduce instances of the errors which have arisen from the neglect of such precautions. Perhaps one of the best known is that I have already alluded to, when James Bruce, a careful explorer, because he had made up his mind that the Blue Nile was the real Nile, passed the White Nile without taking the trouble to examine it, and recorded it as being a comparatively insignificant river. Then there was the case of Sir Samuel Baker, who, having reached the shores of the Albert Nyanza with great difficulty, depended too much on what he was told by the natives, and showed it on his map as extending many miles to the south of the equator. But great responsibility rests also upon those who have the task of compiling a map from the notes of an explorer, and the greatest care has to be taken to show only what is really known, and not what is uncertain. Geographers, whether in the field or in the drawing office, should always hold up before themselves a standard of accuracy higher than it is always easy to live up to.

Geography under its more ancient name of geometry is, of course, the mother of all sciences, although at the present time geometry has got a more narrow meaning, and is perhaps regarded by some as independent of geography, although really only a branch of it. The study of the earth upon which they lived was, to the ancient nations, the most important of all studies, and it is interesting to trace how astronomy, mathematics, geology, and ethnology are all so interspersed with geography that it is difficut to separate them. It is satisfactory to note how from the very first the British Association has always recognised the great importance of geography, since the first meeting of the Association at Oxford in 1832, when Sir Roderick Murchison, so well known to fame, acted as president of the Geographical and Geological Section. These two sciences remained united in the same section until the meeting at Edinburgh in 1850, when Sir R. Murchison was again the president. But, at the next meeting at Ipswich in 1851, they were separated, and while geology remained as the subject of Section C, geography, on account of its great importance, was made the subject of Section E, and the science of ethnology was united with it. Sir R. Murchison was the first president of the new Geographical Section, and was afterwards president no fewer than six times of Section E, showing the great importance attached by him to the study of the science of geography. May I express the hope that the presidents of the section will endeavour in future to follow, however humbly, in the footsteps of that leader of science.

SECTION G.

ENGINEERING.

OPENING ADDRESS BY PROF. ARCHIBALD BARR, D.SC., PRESIDENT OF THE SECTION.

ONE of the great engineers of the past, Leonardo da Vinci, prefaced a collection of observations on various themes, including the mechanical arts, with the remark:—"Seeing that I cannot choose any subject of great utility or pleasure, because my predecessors have already taken as their own all useful and necessary themes, I will do like one who, because of his poverty, is the last to arrive at the fair, and not being able otherwise to provide himself, chooses all the things that others have already looked over and not taken, but refused as being of little value. With these despised and rejected wares—the leavings of many buyers—I will load my modest pack, and therewith take my course." These words describe, with some approach to exactitude, the position in which I find myself, and may form a fitting introduction to an address that will be discursive rather than systematic, and perhaps more critical than constructive.

It may be less true to-day than it was four hundred years ago to say that all important matters concerning the existing state of the mechanical arts have been dealt with in spoken or written addresses. Each year there might be found sufficient subject-matter for a general survey of the ground that has been covered or a sketch of what lies before us. But each important advance is nowadays recorded as soon as it is made, and I do not feel that I have any special call to assume the *rôle* of the historian, nor can I claim any right to don the mantle of the prophet.

A president of this section who is not disposed to deal with the general aspects of the progress being made in the department of science allotted to us can usually find a large enough subject for his address within the limits of that part of our wide field with which his own work has been more particularly identified, and it might be expected that I would devote my address to a discussion of the conclusions at which I have arrived during thirty-six years of practice and experience in the teaching of mechanical science. But so much has been said of late on the training of engineers, and so many divergent and even irreconcilable opinions have been expressed regarding the lines such training should follow, that I feel sure I shall be relieving the apprehensions of some of my audience if I begin by stating that I do not propose to inflict upon you a discourse on that threadbare theme. There are limits to the endurance even of those who practise a profession well calculated to inculcate the virtues of patience and forbearance.

When we have as president of the section one who has broken new paths in the exploration of the territory assigned to us, or to whose labours the fruitfulness of some corner of the domain may be chiefly attributed, we would scarcely be disposed to tolerate the omission from his address of an account of his own special work, in investigation or in practice, and the developments to which it is leading. But while, no doubt, every worker is the chief authority on something or other, the plot he cultivates may be so restricted in area, and its products may bulk so little in the general harvest, as to form no suitable topic to engage the attention of his fellow-workers on such an occasion as this.

When an engineer leaves practice in the great, and takes to the devising and production of what are usually referred to specifically as "scientific instruments" (though all machines and mechanical appliances may properly be classed as such), his colleagues in the profession may be disposed to look upon the change as a degeneration of species. Naturally I am not disposed to accept such a verdict. Remembering the careers of those who did most in the founding of the various branches of present-day practice, I am quite prepared to accept as applicable another phase borrowed from the language of the biologist, and to let it be called a "reversion to a more primitive type." But instead of dealing with the narrow branch of applied science with which my own practice is chiefly connected, I prefer to utilise the short time at my disposal to make some observations upon a larger and more general theme. The thesis which I propose to uphold may not fall very obviously within the scope of the original aims of the British Association, but it has, at least, an intimate bearing on the work of those who are concerned with the applications of mechanical science.

Tredgold's oft-quoted definition of engineering as "the art of directing the great sources of power in nature for the use and convenience of man" may well be taken, and often has been taken, as a text upon which to hang a discourse on the importance of the profession to which many of us belong, the leading part it has played in the process of civilisation, and the dependence of the world to-day on its activities. But the words suggest failures as well as achievements, and responsibilities no less than privileges. The definition suggests that the engineer not only fails in his vocation if he does not accomplish something for the use and convenience of man, but further, that he acts contrary to the spirit of his profession if he directs the sources of power in nature to the unuse[1] or inconvenience of man; and surely we must understand by "man" not the engineer's immediate client but mankind in general. The works of the engineer are to be used by some people; they have to be endured by all.

Taking the highest view of our calling—and surely we do not hold that ours is in any sense a sordid or selfish vocation—the engineer fails in the fulfilment of his duty in so far as his works are detrimental to the health or destructive to the property of the community, or in so far as they are unnecessarily offensive to any of the senses of those who are compelled to live with them. There has been too great a neglect of such considerations. The medical practitioner is held to be negligent of his duty if he acts solely in the immediate interests of his patient, and does not take due precaution to guard against the spread of disease or the offence of the community by the exhibition of unsightly forms. We should take as high a view of our responsibilities.

In his presidential address to the Association last year, Sir Wm. Ramsay said that the question for the engineer has come to be not "can it be done?" but "will it pay to do it?" The answer to this question, in respect to any particular proposal, depends on the width of view we take in answering two preliminary questions: whose interests are we to consider? and, what do we mean by paying? Of course, there are limits that must be set in answering each of these; my present contention is that these limits are usually much too narrowly drawn. A road surveyor may save a few pence or shillings to his county council by leaving a piece of newly metalled road unrolled—because the clock strikes the hour for retiring—and may thereby cause expense, amounting to pounds, it may be to hundreds of pounds, through damage to motor-cars or the laming of horses (not to speak of loss of life or limb), to the users of the road, who are, after all, the clientèle he is there to serve. Does it pay? The authorities of a city will spend large sums on the adornment of the streets with stately and ornate buildings, and on the purchase of works of art—and rightly so, though comparatively few of the citizens can appreciate or even give themselves the chance of appreciating them—while they will tolerate or even be directly responsible for the running on these same streets of quite unnecessarily ugly and noisy tramcars, and congratulate themselves on the drawing of a paltry income from the display of hideous advertisements that are constantly before the eyes of the whole community. Does it pay thus to separate æsthetic from utilitarian demands and interests?

It is too much to assume that engineers could meet all the reasonable demands of their immediate clients without producing, at least temporarily, secondary effects that may be of inconvenience to some members of the community. Bacon, indeed, said that "The introduction of new Inventions seemeth to be the very chief of all human actions. Inventions make all men happy without either Injury or Damage to any one single Person." But Bacon was a philosopher, and dealt with ideals rather than with hard facts, and in his times inventors had not yet begun to dominate all the elements of our physical environment. Had he lived to-day beside one of our country roads he might have had something to say, in another key, regarding motor-cars and dust; or had his lot been cast in the proximity of a great centre of industry he might have modified his conviction of the universality of the benefits conferred by the inventor. He might even have been disposed to agree with a literary man of to-day who is reported as asserting that "The universal and blatant intrusion of Science into our lives has resulted in a total disappearance of repose." Isolated and unqualified statements such as those I have quoted are like proverbs—you can always find two that are directly opposed. The truth lies about midway between these extremes, or rather there are aspects of the facts in regard to which one is an approach to the truth, and aspects in which the other has some justification. Our aim should be to make Bacon's dictum have more of truth and Mr. Stephen Coleridge's assertion have less foundation in fact. And the outlook seems to me to be a very hopeful one, though to be able to take an altogether favourable view of the tendencies of the present time, one must be an optimist of the true order—"One who can scent the harvest while the snow is on the ground."

When we examine into the immediate causes of the injuries and inconveniences that result from our activities we find that they are due in all, or almost all, cases to failures rather than to successes. The more completely the engineer achieves the primary end of his work the less is the damage or injury that can be laid to his charge. If it can be shown that this is a very general law, as I think it can be, we may look forward to the elimination, as a direct result of progress in the mechanical arts, of the nuisances and inconveniences for which, in some measure at least, we must accept responsibility. And not only so, but the converse will be equally true—the more we keep in view the removal or avoidance of anything that can cause offence, the more rapidly we shall advance in the attainment of the primary ends at which we aim. Consider, by way of example, the nuisance to which I have referred, and of which we hear so much—the raising of dust by motor-cars. I shall not discuss the debated question as to how far the motor-car produces dust, or only distributes it, nor shall I deal in detail with the possible remedies. We hope to have a paper on the subject at this meeting from one of our leading authorities. For my present purpose it suffices to point out that it is no part of the function of a road surface to fritter itself down into dust under traffic of any kind. The ideal road would be one that would not wear at all, and the nearer we approach this ideal of a permanent road surface, the less will be the inconvenience caused, not only to those responsible for the upkeep of the road, but to the general public. And conversely, the more attention we give to the devising of a dustless road the more rapid will be our advance towards the provision of one best suited for all the purposes which a road is intended to serve. We had dusty roads

[1] We have no word to denote very clearly the negative of *use*, as the term here applied: *unuse* may serve for the present.

before the motor-car came into being, but the demand that is being forced upon the engineer to eliminate this nuisance is leading to an improvement of our roads for all users. The inventors of the automobile will yet merit the thanks even of those who, bemoaning the blatant intrusion of science into our lives, may discard the railway train and the motor-car and take to the stage-coach of their grandfathers with a view to the recovery of some of the lost repose.

Again, the combustion of fuel does little harm to anyone; it is the imperfection of the combustion that is the main cause, almost the sole cause, of injury to health, to property, and to the amenity of populous centres. Of course, one knows that smokeless combustion is not necessarily, nor always, the most economical, but that is only because we have not yet learned how to use fuel in anything like a perfect manner. But all the tendencies at the present time are towards improvement, and the more attention we pay to the elimination of the smoke nuisance the more rapid will be our progress in the economical use of one of the most valuable of our inheritances. It is therefore clearly the duty of every engineer who has to do with power or heat production—for the credit of his profession and even in the interests of his immediate clients—to consider the use and convenience of all who can be affected by the work for which he is responsible. The time is not far distant when the direct burning of bituminous coal in open grates will be looked upon as not only a source of serious harm but as a culpably wasteful practice. Great progress has been made in processes for the partial distillation of coal by which a free-burning and quite smokeless fuel is prepared and valuable by-products (so-called) are conserved. If all engineers concerned with the design and application of plants in which coal is used had a due sense of their responsibilities to the community, progress would have been, and would to-day be, much more rapid; and economies would be effected that would, in themselves, amply justify the application of more scientific methods of utilising the constituents of a very complex material, which we are too apt to look upon as merely a convenient source of heat—plentiful enough and cheap enough, as yet, to be used in a most wasteful manner. It will not be to the credit of our profession if it should require restrictive legislation not only to prevent a gross interference with the health and comfort of the community and the amenities of our centres of industry or of population, but to effect economies in the utilisation of the chief of the sources of power which it is our function to direct to the best advantage of all concerned.

In other directions also we see that progress towards economy is leading to a reduction, and possibly to the entire elimination, of all the nuisances associated with the older methods of power and heat production. The great improvements that have recently been made in producer plants and gas engines have rendered out of date, as regards economy, at least the smaller sizes of steam plants which are so fruitful a source of injury and inconvenience to the community; and we now have engines of the Diesel, and the so-called semi-Diesel, types that can utilise natural oils, and oils obtained in the distillation or partial distillation of coal, not only with an efficiency hitherto unattained in heat-engines, but "without injury or damage to any one single person"—except possibly the maker of inferior[2] plants.

Present indications point to the coming of a time, in the near future, when the power and heat required for industrial and domestic purposes will be distributed electrically, in a perfectly inoffensive manner, from large central stations; and even at these stations there will be no pollution of the atmosphere that could give the most sensitive of critics any just grounds of complaint against the intrusion of science into our lives. In his presidential address to the Institution of Electrical Engineers in November, 1910, Mr. Ferranti dealt in a most masterly way with this, which is undoubtedly the greatest of the many schemes at present before the engineering profession. That address reads like a chapter from a romance of Utopia, but unlike most of the forecasts that have been presented to us of ideal conditions in a world of the future, the system which Mr. Ferranti sketches out, and advocates with so much knowledge and convincing argument, does not depend for its reasonableness on the postulation of a perfected humanity. It would not only provide vastly improved conditions of life for the community as a whole, but it would satisfy the more selfish aims of the users of power and the makers of machinery, by increasing the economy of production and stimulating the demand for mechanical appliances. No doubt there may be some who will hold that to commend any worthy scheme, to those who might carry it out, by an appeal to their selfish interests is an altogether immoral kind of argument. I do not think so. Advancement of the race through benefits to the individual is, at least, not inconsistent with nature's method of securing progress. However much we may desire to develop a purely altruistic spirit in men of all classes, we must meantime make the best of human nature as it is, and recognise that the rapidity of our progress toward better conditions of life will be in proportion to the advantages that each advance can promise to those who would be immediately concerned in its realisation.

It is just a hundred years since passengers were first carried on the Clyde in a mechanically-propelled ship, and to-day—when they are not too completely obscured by smoke—we can see the successors of the *Comet* plying on that river with power plants of greatly superior overall efficiency but showing little advance in regard to the combustion of the fuel. Had the emission of smoke from river craft been prohibited years ago, there is little doubt that engineers would have let few days pass without arriving at some solution of the problem of inoffensive power production, and the demand for economy would have looked after itself. How much better it would be were engineers to take the wider view of their duties and responsibilities to which I have referred, and realise that they are acting contrary to the true spirit of their profession when they produce appliances that pollute the atmosphere for miles around to the hurt and inconvenience of those whose "use" they are intended to serve. But this year a ship has left the Clyde that we hope may be the forerunner of a new race which will attain a higher efficiency than any of the direct descendants of the *Comet*, and that will ply their trade without inconvenience to man or beast, who can claim some right to be permitted to enjoy an unpolluted atmosphere and the measure of sunshine which nature—sparingly enough in those regions—intended to provide.

But there are injuries which we may inflict upon the community other than those to health and physical comfort. Everyone, even the least cultured, has some sense of the beautiful and the comely, and is affected by the aspects of his environment more than he himself can realise. The engineer, then, whose works needlessly offend even the most fastidious taste is acting contrary to the spirit of his profession, at its best.

[2] My typist in transcribing a rather illegible draft of this passage substituted for the adjective I have here used the less restrained, but perhaps equally appropriate one, "infernal," but I noticed this in time to amend the emendation. I had no intention to speak so candidly of any of the works of members of my own profession.

There has been far too great a disregard of æsthetic considerations in the everyday work of the engineer—we usually take a too exclusively utilitarian view of our calling. We should not be prepared to accept, as referring to the arts we practise at their best, the distinction drawn by a philosophical writer between "the *mechanical* arts which can be efficiently exercised by mere trained habit, rote, or calculation," and "the fine arts which have to be exercised by a higher order of powers." [3] And I think it can be shown that a greater regard for artistic merit in our designs would not necessarily lead to extravagance, but, in many cases, would conduce to economy and efficiency. It is at least true—and much less than the whole truth—that greater artistic merit than is commonly found in our works could be attained with no sacrifice of structural fitness, or of suitability for the purposes they are designed to serve.

There was a time when engineers made desperate attempts to secure artistic effects by the embellishment (?) of their productions with features which they believed to be ornamental. Fortunately the standard of taste has risen above and beyond this practice in the case of most members of our profession and most of our clients. We are all familiar with illustrations of philosophical instruments, and other mechanical contrivances, of the early times, that vied in lavishness of adornment—though not in artistic merit—with those wonderful astronomical appliances that were carried—as trophies of war!—from Pekin to Sans Souci. Many of us can remember a time when the practice had not altogether disappeared, even in the design of steam engines, lathes, and other products of the mechanical engineer's workshop. I well remember in my apprenticeship days the building of a beam engine that was a triumph of ingenuity in the misapplication of decorative features. In place of the mildly ornamented pillars and entablature of Watt's design, there was provided, for the support of the journals of the beam, a pair of A frames constructed in the form of elaborately moulded Gothic arches flanked by lesser arches on each side, while the beam itself, and many other parts, were plentifully provided with even less appropriate embellishments borrowed from the art of the stonemason. It is some consolation to remember that the clients for whom the engine was built were not of this country, and that the design itself was not a product of the workshop that was favoured with the contract to produce this amazing piece of cast-iron architecture. We have all seen wrought-iron bridges the inattractive features of which were concealed by cast-iron masks—in the form of panelling, or of sham pillars and arches with no visible means of support—that not only have no connection with the structural scheme, but suggest types of construction that could not, by any possibility, meet the requirements. Structures of this kind remind one of the pudding which the White Knight (with good reason when we remember the characteristics of his genius) considered the cleverest of his many inventions. It began, he explained, with blotting-paper, and when Alice ventured to express the opinion that that would not be very nice, he assured her that though it might not be very nice *alone* she had no idea what a difference it made mixing it with other things—such as gunpowder and sealing-wax.

There are, and must always be, wide differences of opinion regarding what is good or bad in matters of taste, but we may go so far in generalisation as to say that we can admire the association of elements we *know* to be incongruous only in compositions that are intended to be humorous. "All human excellence has its basis in reason and propriety; and the mind, to be interested to any efficient purpose, must neither be distracted nor confused." [4] But to be able to judge of the propriety or reasonableness of any composition we must have some knowledge of the essential qualities and relationships of its component parts, and excellence cannot depend upon an appeal to ignorance. We can quite imagine that the White Knight's pudding would appeal as an admirable and most ingenious concoction to one who lacked a knowledge of the dietetic value of blotting-paper and was willing to take for granted the excellence of gunpowder as a spice and of sealing-wax as a flavouring. No artist would be bold enough to include a polar bear or a walrus in the composition of a picture of the African desert, nor be prepared to consider as a legitimate exercise of the artistic imagination the depicting an Arab and his camel wending their weary way across the Arctic snows. He would recognise the incongruity, and might even realise that it is only a lack of imagination or of true inventive power that could lead anyone to resort to such measures for the securing of a desired colour scheme. These are lengths to which even artists will not go in the arrangement of elements in a composition. But an artist *will* secure a colour scheme at which he aims by the introduction into his landscape of a rainbow in an impossible position, or of impossible form or dimensions, or with colours arranged according to his own fancy, though in this there is a much more essential unreasonableness. A polar bear might be transported to the desert, and an Arab might conceivably find his way to the regions of snow and ice, but a rainbow cannot wander from the place assigned to it by nature, nor can it have other than the ordained form or dimensions or sequence of colours. No artist would paint a figure holding a candle and make the light fall on the side of the face remote from the source, but he will, and usually does, paint the moon illuminated on the side remote from the sun. Why? Simply because he has not before his mind the essential absurdity of the scheme, if indeed he knows why the moon shines. Artists who deal with nature in any of its aspects may be commended to "mark, learn, and inwardly digest" Whistler's definition of their calling: "Nature contains the elements in colour and form of all pictures . . . but the artist is born to pick and choose, and group with science, these elements, that the result may be beautiful." Whether or not we are to understand that Whistler intended to include an accurate knowledge of physical facts and phenomena in what he calls *science*, he cannot have meant anything less than *sense*.

So in regard to the arts of construction, we may say that mechanical science provides the elements of all structures, and the craftsman—be he called engineer or architect—is born to pick and choose, and group with science, these elements, that the result may be useful—and not devoid of grace.

The only valid excuse for such departures from the fit and rational in painting or in structural design as those which I have instanced is ignorance on the part of the designer of the nature of the elements he employs, or a lack of skill to devise a possible or reasonable arrangement of details that will secure the general effect he desires.

It may almost savour of sacrilege to quote, in this connection, from the writings of that "Wild, wilful, fancy's child" the story of whose eight short years of life and literary work Dr. John Brown has given in his charming "Pet Marjorie"—a record of perhaps the shortest human life that has formed the subject of a biography. But the lines are too pertinent to my purpose to be withheld, and the frankness of the

[3] Enc. Brit., eleventh edition, article "Art."

[4] Mr. Duppa's "Life of Michelangelo."

confessions they contain, of a childlike limitation of artistic power, may be commended to those who practise either the fine arts or the arts of construction, and feel compelled to "trust to their imagination for their facts," or to resort to the association of incompatible details for lack of knowledge, or of ability to attain their ends by more reasonable means.

Marjorie writes of the death of James II.:—

"He was killed by a common splinter,
Quite in the middle of the Winter;
Perhaps it was not at that time,
But I could find no other rhyme?"

"Quite in the middle of the winter" describes August 3, 1460 A.D., with no wider licence than we find assumed in the works of more experienced, if less candid, artists and craftsmen. Again in her sonnet to a monkey—written, we must remember, when she was six or seven years of age—she acknowledges the compelling power of an artistic aim:—

"His nose's cast is of the Roman:
He is a very pretty woman.
I could not get a rhyme for Roman
So was obliged to call him woman."

It may seem that I have wandered widely from my text: those who found discourses on texts usually do! But there is, or ought to be, a closer connection than is usually recognised between the work of the engineer and that of those to whom we usually restrict the title of artist. There was no great gulf fixed between the fine arts and the utilitarian arts in earlier times. Some at least of those to whom we owe the greatest advances in the fine arts were eminent also in the arts of construction. We may claim such men as Michelangelo, Raphael, and Leonardo da Vinci as masters in the arts of construction as well as in those with which their names are usually associated. The separation of the beautiful and the useful is quite a modern vice. But much that I have ventured to say in the digression—if such it be—is applicable, with little or no alteration of terms, to the work of our own profession. The architect or engineer who, for the sake of effect, fills the space between the flanges of a beam or girder with slabs of stone, or cast-iron pillars and arches, that could not fulfil the function of a web, exhibits just the same lack of skill as Pet Marjorie owns up to—shall I say?—like a *man*. Such practices have no "basis in reason and propriety," and the employment of such "decorative features" is certainly not a "grouping of elements with science." It is said that "The highest art is to conceal art"; the lowest in matters pertaining to our profession is to conceal ill-devised construction with false and senseless masks. But what I have said has, I think, a sufficiently obvious bearing on the mechanical arts—I need not further point the moral.

There is an old maxim to the effect that "the designer should ornament his construction and not construct his ornament." This is an admirable rule so far as it goes, but it should be subordinated to a higher rule, that he should ornament his structure only if he lacks the skill to make it beautiful in itself. A structure of any kind that is intended to serve a useful end should have the beauty of appropriateness for the purpose it is to serve. It should tell the truth, and nothing but the truth, and if its character be such that it can be permitted to tell the whole truth, so much the better. It should be beautiful in the sense in which we commonly use the term with respect to a machine—we call a mechanical device beautiful only if it strikes us as accomplishing the end for which it is designed in the simplest and most direct way. Our works—like the highest creations in nature—should be beautiful and not beautified. "Beautified" should be considered a vile phrase when applied to a work of construction, no less than when used to characterise a fair Ophelia. Artists accept the human form, at its best, as the highest embodiment of grace and beauty, but there is not a curve in the figure that is not the contour of some structural detail that is there for a definite purpose. The practice of resorting to extraneous adornments to minimise crudities of structural scheme had its rise—if I mistake not—in the comparatively recent times when culture and taste were at their lowest. It is specially characteristic not only of earlier times, but of the earlier stages of the design of any particular product. It has already disappeared in some cases, and will continue to disappear from the practice of the arts of construction as skill and taste develop. I have already alluded to the abandonment of ornament in the design of machines, and I think there can be no one, with any sense of the fit and pleasing, who does not approve this change in practice. The stage coach and horses of former times were lavishly decorated—the carriage of to-day is more graceful and pleasing in virtue of the simple elegance of its lines. In the best domestic architecture of to-day we see the same tendency to trust for effect, more and more, to an artistic grouping of the lines and masses of essential parts and the gradual abandonment of purely decorative features, without and within. There was a time when the hulls and riggings and sails of ships were lavishly ornamented; now even the figurehead—the last remnant of barbaric taste—has disappeared; and do we not find in a full-rigged ship of to-day (or yesterday, perhaps one should say) a grace and dignity that no extraneous embellishments would enhance? From the racing yacht the designer has been forced, by the demand for efficiency, to cast off every weight and the adornments that so beset the craft of earlier times, with the result that there is left only a beautifully modelled hull, plain masts, and broad sweeps of canvas, and we can scarcely imagine any more beautiful or graceful product of the constructive arts. These examples will serve to illustrate the contention that the attainment of the highest efficiency brings with it the greatest artistic merit. But in the development of the yacht of to-day, through many stages, the designer has been forced, from time to time, to strive to combine grace with efficiency. Selection on the part of clients must have eliminated ungraceful forms when more beautiful ones could be found, and therefore the advance has been rapid. I think I may appeal to this illustration to support the further contention that advance in efficiency may be helped and not hindered by keeping in view an æsthetic as well as a utilitarian aim. Further illustrations will occur to anyone who has studied the development of design of structures or machines.

It is a matter of constant remark, and with justice, that steel bridges, as a class, are much less pleasing to the eye than those of stone. The reasons for the contrast in artistic merit are not far to seek. The building of stone bridges is an ancient art, and survival of the fittest, and selection—even with little creative skill on the part of the designers—would have led to the development of types having, of necessity, at least the elegance of fitness. But further, this art has come down through the times to which I have referred when artistic and utilitarian aims had not yet been divorced, in the practice of the crafts; and further still, the practice of building in stone has been in the hands of architects as well as of engineers, and architects are expected to be artists, and are trained as such. On the other hand, construction in steel is a very modern art, and it has been in the hands of engineers who usually neglect, if they do not despise, the study of the fine arts. But why have architects, with their artistic training, not succeeded in producing structures in steel as admirably as those they design in stone? Partly, no doubt, because they are hampered by tradition. They have not yet fully realised the difference in spirit that must characterise fit designs in the newer and the older materials. No one can be an artist in any material the possibilities and limitations of which he has not fully mastered. Again—if a common engineer may venture the criticism—the architect, as a rule, has not sufficiently mastered the *science* of construction, and has been too much addicted to taking the easy course of adopting a decorated treatment instead of striving to secure elegance of structural scheme as such; and decoration, at least on anything like traditional lines, is wholly incompatible with the best possibilities of steel as a structural material. Progress is being made in the art of designing efficient and graceful structures in metal, but the best results can only be attained by a designer who has a thorough scientific and technical knowledge of the properties of steel and the processes of its manipulation on the one hand, and cultured artistic sense and capacity on the other. These should not be considered as appropriate equipments for separate professions.

There are many, however, who have a rooted conviction that structures in steel can never be so beautiful as those in stone. This I believe to be altogether wrong. It arises partly from the crudity of design that characterises most of the steel structures that have yet been erected, and partly from preconceived notions as to what is fitting in proportions and massiveness. We can quite imagine that a native of the Congo region whose notions of the proportions suitable and comely for a quadruped were founded on his familiarity with the hippopotamus would, at first sight, consider the racehorse sadly lacking in substance and solidity; but, in time, he might come to recognise some measure of gracefulness in a creature that has been developed to meet requirements that hitherto he had not fully considered.

Mr. Wells has said in his "Modern Utopia," "the world still does not dream of the things that will be done with thought and steel when the engineer is sufficiently educated to be an artist, and the artistic intelligence has been quickened to the accomplishment of an engineer." But we need not postpone until the advent of a complete Utopia, the full realisation of our duty to practise our profession, as far as in us lies, with due regard for the material interests and the æsthetic susceptibilities of all who can be affected by the works for which we are responsible.

NOTES.

A PUBLIC meeting will be held at the Mansion House on Wednesday, October 23, in support of the memorial to Lord Lister.

THE superintendent of the Meteorological Office Observatory at Eskdalemuir, near Langholm, Dumfries, reports that the seismographs at the observatory recorded a large earthquake at 11.30 p.m. on September 13. The centre of the disturbance is indicated at latitude 40·4° N., longitude 27° E., a point situated at the south coast of the Sea of Marmora.

WE learn from *The Lancet* that the Riberi prize of the University of Turin, amounting to 20,000 lire (about 800*l.*), will be awarded after the close of the year 1916 for the work which is adjudged to have most advanced the science of medicine. Such work, if published, must have been printed after 1911. Or it may be sent in before the end of 1916, in print or typoscript—the English language is admissible. Further information may be obtained from Prof. Dr. Oliva, Turin.

A SPECIAL number of the *Atti della R. Accademia dei Lincei*, containing the report of the proceedings at the anniversary meeting last June, announces a gift of 400*l.* from Dr. Gino Modigliani towards the publication of the works of Leonardo da Vinci, and a legacy to the academy of 2000*l.*, as well as of many of her personal effects, from the estate of the late Signora Celli Dutuit. Prizes given by the King of Italy have been awarded to Prof. Ernesto Manasse for mineralogy and geology, and to Prof. Giuseppe Chiovenda for jurisprudence and political science. The Minister of Public Instruction also gives four prizes, each of which has this year been divided, the recipients being Profs. G. Ercolini and A. Amerio for physics, Profs. A. Quartaroli and R. Salvadori for chemistry, and Profs. Enrico Carrara, Donadoni Eugenio, Levi Ezio, and Ribezzo Francesco for the two philology prizes. A prize founded by Santoro is awarded to Prof. Costantino Gorini for his discoveries in the bacteriology of cheese, while another most useful prize, founded by the late Alfonso Sella for assistant lecturers in the department of physics, is awarded to Dr. Paolo Rossi, of the University of Naples.

WE announced with regret last week the death on September 4, at forty-two years of age, of Dr. Stanley Dunkerley, formerly professor of engineering in the University of Manchester. Dr. Dunkerley was educated at the Burnley Grammar School and Manchester University, where he graduated in 1900 with honours in mathematics, and took, a year later, the degree in engineering. After two years on the construction work of the Manchester Ship Canal, he obtained the Bishop Berkeley fellowship, and returned to the University to carry out researches in the Whitworth Engineering Laboratory under the direction of the late Prof. Osborne Reynolds. Dr. Dunkerley held appointments as assistant-lecturer in engineering at Liverpool University and at Cambridge. In 1897 he was appointed professor of applied mechanics at the Royal Naval College, resigning in 1905 to succeed Prof. Osborne Reynolds at the Manchester University. He had only held this post three years when ill health compelled him to resign. Dr. Dunkerley was strongest on the mathematical side of engineering. His most important contributions to engineering science are the paper on the whirling and vibration of shafts published in the Transactions of the Royal Society, and an investigation of the straining actions in crank shafts, which appeared in the transactions of the Institute of Naval Architects. He was the author of text-books on mechanism and hydraulics. In 1905 his University conferred on him the doctor's degree in science, and in the same year he was elected a member of the Institution of Civil Engineers.

THROUGHOUT the wide circle of mining engineers the announcement of the death of Mr. J. A. Chalmers at Bournemouth, on September 9, will be deeply regretted. Born in 1864, son of the Rev. Dr. Chalmers, an esteemed missionary in China, Mr. Chalmers in 1889 took his diploma as an Associate of the Royal School of Mines, and left the same year to take up professional duties in the Transvaal. There he afterwards became an assistant engineer to the Consolidated Goldfields of South Africa, under J. H. Hammond. Apart from the important work which came to him in this connection upon the Rand, Mr. Chalmers, with Dr. F. H. Hatch, accompanied Mr. Hammond when, in 1894, this engineer made an important mining reconnaissance into Rhodesia, a land which had not at that time long been under British influence. Later, in the year 1895, he collaborated with Dr. Hatch in the preparation of "The Gold Mines of the Rand," the first important work on the Witwatersrand Goldfields. Mr. Chalmers was thus by his own good work forced to the front, and during the next ten years important commissions took him for their fulfilment to all parts of the world. Then it was found that a disease, all unsuspected, had taken a hold on him that attention and skill could do nothing to loosen. Slowly but surely Mr. Chalmers sank, Davos put off the day, Bloemfontein the hour, but six weeks after his return to this country death came, at the early age of forty-eight. During all this time the many friends which his modesty had made for him failed not in frequent inquiry, and now that he has gone all mining engineers, even the most self-assertive, will cherish the memory of this man of quiet quality.

THE new Allegheny Observatory, situate in Riverview Park, Pittsburg, was dedicated on the afternoon of Wednesday, August 28, in the presence of the members of the Astronomical and Astrophysical Society of America and of many of the Pittsburg friends of the institution. The principal instruments of the new observatory are a 13-in. visual refractor, a 30-in. reflector (a memorial to the late James Edward Keeler), and a 30-in. photographic refractor (a memorial to William Thaw and his son, William Thaw, jun.). The last of these telescopes is not quite completed, as the objective remains to be supplied. Addresses were given by Dr. John A. Brashear, chairman of the observatory committee; by Dr. Samuel Black McCormick, Chancellor of the University of Pittsburg, of which the observatory forms the astronomical department; by Dr. Frank Schlesinger, director of the Allegheny Observatory; and by Prof. E. C. Pickering, director of the Harvard College Observatory. Mrs. William Reed Thompson, the daughter of William Thaw and the sister of William Thaw, jun., closed the ceremony with the unveiling of the memorial tablet on the Thaw telescope.

THE objections which were indicated some time ago in *Engineering* to the style of monoplane which is dependent on the rotary type of engine have been illustrated by the death of four army officers in one week, and give occasion for a strong article in our contemporary for September 13. The French Deperdussin monoplane, in which Captain Hamilton and Lieutenant Stuart lost their lives, broke in the air; as this machine won the 2000*l*. prize in the War Office competition it is not unreasonable to suppose that it represents the most advanced stage of monoplane construction. Its failure shows that however much care may be exercised in the choice of a monoplane of the ordinary type, it cannot be absolutely trusted to last for a month without breaking in mid-air. The cause of the failure of the Bristol monoplane, in which Lieutenants Hotchkiss and Bettington were killed, was not brought to light at the inquest. The Deperdussin failure, it seems to be generally agreed, was caused by some part of the revolving engine failing and wrecking the aëroplane. A real endeavour should be made to secure a supply of engines of other than the revolving type. Where this type has to be used some provision should be made for safety in case of parts breaking. This might be done by placing a strong shield between the engine and any parts it might otherwise damage.

AT the French Army manœuvres some portable apparatus for wireless telegraphy on aëroplanes, designed by M. Rouzet, is being officially tested under war conditions. M. Rouzet's apparatus, which was described recently by the Paris correspondent of *The Morning Post*, embodies the novelty—so far as aëroplane work is concerned—of using a rotating spark-gap. This consists of a fixed and a movable disc each carrying a number of metal points between which the sparks pass while the movable disc is rotated rapidly. The disc, and also a small alternator, are driven by the aëroplane motor, and the current, which is generated at a pressure of 110 volts, is raised to 30,000 volts by a transformer, and led to a condenser and to the gaps. By setting the disc properly with respect to the dynamo windings and poles, the sparks can be made to occur when the condenser is just fully charged. The advantages of this mode of operation are, of course, very well known as regards larger units, but it seems that rotating spark-gaps have not been used before in French aëroplane work. The oscillations produced by the discharge of the condenser through the spark-gap are transferred to the antenna by means of a high-frequency auto-transformer of the Oudin pattern. The antenna consists of an aluminium wire 100 ft. long, and can be rolled up or unrolled by the operator by aid of a small winch, while provision is made whereby the pilot can cut the antenna adrift in case of necessity. Instead of the earth connection employed in a land or ship station, a wire network is, as usual, spread along the wings of the aëroplane, and thus the antenna and its "electrical counterpoise" constitute a self-contained Hertzian oscillator. The power of the dynamo is 200 watts, and the distance already worked over is between fifty and sixty miles.

A LECTURE on non-operative methods as applied to cancer was delivered by Prof. V. Czerny, of Heidelberg, on September 16, before the Association of German Naturalists and Physicians at Münster, in Westphalia. From a report in *The Morning Post*, we learn that Prof. Czerny confessed at once that a specific cure for cancer had not yet been discovered, and perhaps never would be found. Every year, he said, we hear of new discoverers who promise more or less infallible results, but close examination of their specifics shows their worthlessness. Within the last year or two chemical therapeutics had received a fresh impulse of scientific value owing to the results of experiments on animals, and it was now tolerably certain that blood treatment must take the place of the former treatment of stomach and intestines. Turning to rav therapeutics, Prof. Czerny admitted its efficacy after the knife in removing injuries, but was not inclined to attach very great importance to electricity applied as rays. In his opinion the more remedies we are confronted with the more difficult it is to find one's way to a proper treatment. This, he said, should be the work of the numerous institutes springing up in various civilised lands the express object of which is the study of this terrible scourge. On the whole, says the correspondent of *The Morning Post*, the address was couched in rather pessimistic tones, and the lecturer did not seem to share the hopeful views which have been lately expressed regarding the chemical, as opposed to the operative, treatment of the disease.

IN *The Popular Science Monthly* for August Prof. Richard Pearce gives an interesting historical survey of research in medicine, and Dr. Heinemann discusses cold-storage problems. The latter states that with careful treatment there are no appreciable differences in chemical composition between fresh meat and meat kept frozen for a period of two years.

IN the Farmers' Bulletin, No. 487 (U.S. Department of Agriculture), by Dr. Langworthy and Caroline Hunt, cheese and its economical uses in diet are considered. A number of recipes for the preparation of cheese dishes is given, and it is stated that cheese does not differ materially in its digestibility from meat, and, weight for weight, contains rather more protein and 50 per cent. more fat than cooked beef, and hence is a valuable food.

WE have received the August and September numbers of *The Child*, a monthly journal devoted to child welfare. Each contains a number of articles of general and special interest to those who have to deal with children—parents, educationists, doctors, and health visitors—notably one by Dr. Mary Scharlieb on adolescent girls from the point of view of the physician, in which the characteristics and management of adolescent girls are critically considered.

DETAILS are given of an improved respiration calorimeter, and the results of experiments with it by the U.S. Department of Agriculture (Exp. Station Record, vol. xxiv., No. 7, and Year-book for 1910). The influence of mental activity on metabolism was one of the subjects investigated, and in half the cases at least sustained mental effort had no positive influence upon the transformations of matter and energy within the body. The gaseous exchange and energy metabolism during the ripening of picked fruit, the germination of seeds, and the incubation of eggs are other subjects under investigation.

IN the August *Fortnightly Review*, Mr. Adolphe Smith discusses the present menace of cholera. He points out how cholera has been more or less prevalent on the Continent in various districts during the last three or four years, and directs attention to the danger that exists of the introduction of the disease into this country, particularly by way of some of the smaller ports, where sanitary administration is still very inadequate. He pleads for the establishment of a Ministry of Public Health, and for the burden of port sanitary administration to be placed on the country as a whole, and not on the local authority. Finally, he maintains that despite improvements in water supply, sewage disposal, and general sanitary conditions, poverty is the most potent of all those grim allies that join together to render devastating epidemics possible!

A RECENT number of the Annals of Tropical Medicine and Parasitology (vol. vi., No. 2) contains the results of investigations by H. B. Fantham and Annie Porter upon the destructive bee disease commonly known as "Isle of Wight Disease," together with a detailed description of the parasite and its life-history. The parasite, *Nosema apis*, belongs to the order Microsporidia, and is a close ally of *N. bombycis*, the parasite of silkworms, which causes the disease only too well-known as "pebrine," the subject of memorable researches by Pasteur. The method of infection was found to be contaminative; hereditary infection through the egg, as in *N. bombycis*, though by no means improbable, has not yet been proved to occur. The only certain means of destroying the resistant spores of the parasite and eradicating the infection is by fire. It is to be regretted that the authors should have thought it necessary to complicate the bibliography of Protozoa, already sufficiently vast, by setting forth their important results in three distinct and separate memoirs, which, as they are printed successively in the same journal, might easily have been included under one title.

MR. LUDWIG GLAUERT describes, in the first volume of the Records of the Western Australian Museum and Art Gallery (Perth, 1912, p. 47), an important series of remains of extinct marsupials from Balladonia. Eight of the species have not been recorded previously from Western Australia. The author supports Owen's view that Thylacoleo, the "marsupial lion," was carnivorous, and illustrates the worn enamel of its incisors.

To the July issue of *The Agricultural Journal of India* Mr. T. B. Fletcher, entomologist to the Madras Government, communicates an article, illustrated by a coloured plate, on termites or white ants. At the commencement reference is made to the modern view that these insects are not Neuroptera, but are more probably related to cockroaches and other Orthoptera, termites and cockroaches having many structural peculiarities in common. Then follows a full account of termite social economy.

A SHORT time ago the editor of *Popular Mechanics* (U.S.A.) conceived the idea of taking the votes of a number of scientific men on what inventions they considered to be the "seven wonders of the modern world," and for this purpose a list of numerous inventions was circulated, from which seven had to be selected. The result is published in the August number, and the seven inventions which received the highest number of votes are as follows:—Wireless, telephone, aëroplane, radium, antiseptics and antitoxins, spectrum analysis, X-ray.

WE learn from the daily Press that considerable anxiety is felt in France regarding the frequent deaths that have recently occurred through eating poisonous fungi. Three precautionary measures are suggested. One is to avoid gathering mushrooms having a persistent volva at the base of the stem; another is to boil every mushroom in water with a little salt; and a third is to have some animal charcoal at hand to be swallowed when a case of poisoning occurs. It is stated in the notices that no species is poisonous in which the volva is absent. It would be, however, wrong to regard all such species as esculent, for several well-known kinds having this characteristic certainly produce temporary, if not fatal, poisoning, at least unless subjected to prolonged boiling.

Two useful lists of South African plants have recently been published. Mr. J. Burtt-Davy and Mrs. Reno Pott-Leendertz (Annals of the Transvaal Museum, vol. iii.) have compiled a "first check-list" of the flowering plants and ferns of the Transvaal and Swaziland, enumerating about 3300 species. Mr. F. Eyles (*South African Journal of Science*, vol. viii.) gives a preliminary list of the plants of southern Rhodesia, comprising about 1700 flowering plants and ferns.

A NEW and curious species of "ground bean" (*Kerstingiella geocarpa*, Harms) from tropical West Africa is described and figured in the Kew Bulletin, No. 5, 1912. When the flowers are fully developed they are close to the ground, and after fertilisation the hitherto short stalk of the ovary lengthens into a long "carpopodium," which turns down and drives the young pod into the ground, where it matures. The same number contains a description and fine plate of a remarkable new spurge (*Euphorbia multiceps*, Berger) received at Kew from South Africa; it resembles a green pineapple with a number of spikes protruding irregularly from it, the stout fleshy axis being densely covered with short coral-like horizontal branches—the spikes are barren inflorescences, but no flowers have been seen. There is also a useful compilation of the various timbers and trees to which the terms tulipwood and tulip tree have been applied, just as other names (gum, rosewood, cedar, pine, mahogany, &c.) are indiscriminately applied to diverse timbers and trees.

MR. CECIL H. HOOPER has contributed to *Irish Gardening* for June and July an account of some interesting experiments on the pollination of hardy fruits, made by himself, Mr. F. Chittenden, and others. These experiments were made in order to ascertain whether fruits can set and mature without the aid of bees, whether mature fruit can be obtained by pollination with the pollen of the same variety or the same flower, and whether better fruits result from pollination with pollen of another variety. It was found that gooseberries and currants, raspberries and loganberries, though freely self-fertile, set better fruit when visited by bees; that strawberries are apparently to some extent wind-pollinated, though this needs confirmation. As is well known, more or less complete self-sterility is common among the many varieties of cherry, plum, apple, and pear; in the majority of cases pollen from another variety is essential for fruit formation. Details are given of numerous interesting results obtained by covering otherwise untouched flowers with muslin bags, by brushing with pollen from the flower's own anthers or from those of other plants of the same variety, and by pollination with pollen from other varieties. In connection with the interplanting of different varieties in orchards, lists are given according to the times of flowering. The author estimates that about 80 per cent. of the pollination of hardy fruits is done by the hive bee, about 15 per cent. by the various humble bees, and the remainder by miscellaneous insects.

THE meteorological year-book for Bremen, 1911, one of the regular German series, contains two important summaries in addition to the observations for the year in question:—(1) A discussion of the daily maximum and minimum temperatures for 1890–1910 (twenty-one years) by Mr. J. Siedenburg; and (2) monthly tables of the climate of Bremen for 1876–1910 (thirty-five years). This long series gives an absolute maximum temperature of 93·9° in May and an absolute minimum of −13·0° in December, but a reading of −17·1° is quoted as having occurred on January 23, 1823. The heat and drought of 1911 lasted from July 4 to September 27 (twelve weeks). Prof. Grosse ascribes the abnormal conditions principally to the shifting of the Azores pressure maximum to the north-east, and possibly to some extent to the approximate occurrence of the minimum sunspot period.

IN the *Atti dei Lincei*, xxi. (2), 2, Prof. Augusto Righi describes experiments on the convection of ions produced by magnetic or magneto-kathodic rays. According to the author's hypothesis these rays cause some of the electrons to unite with positive ions, the combination behaving like a double star or the system formed by a planet and its satellite. Once formed, they are carried by magnetic action from regions of greater to regions of lesser magnetic force, where the elements again frequently become dissociated. To dectect the presence of these ions, Prof. Righi makes use of a small cylinder of paper suspended by a fibre in the magnetic field generated by a second induction coil. According to theory the ions, by their impact on the cylinder, should cause the latter to rotate in the same direction as the magnetising current of the coil, and this was observed to be the case.

CERTAIN formulæ relating to the pressure of fluids on oblique planes have been recently quoted as "Avanzini's law." Col. de Villamil has made several inquiries as to where these laws were published, and having failed to obtain the information from others, has taken the matter up himself, and publishes an abstract of Avanzini's work in *The Aëronautical Journal* for July. The work in question was published in the *Memorie dell' Istituto nazionale italiano* at Bologna early last century, and deals with experiments on the relations between the velocity of a plate in still water, the angle of attack, the position of the centre of pressure, the density of the fluid, the length and breadth of the plate. The paper is illustrated by copies of the original diagrams, and contains experimental data. There are, however, several errors which require correction in the formulæ.

THE annual report of the results of sight tests in the Mercantile Marine, for the year ending on December 31, 1911, just published as a Parliamentary paper (Cd. 6370), shows a slight increase in the percentage of failures, both in form and in colour vision, over the returns of the preceding year. 7309 candidates were examined, with 117 failures in form vision, none of whom were re-examined, and with 192 failures in the first examinations for colour vision, of whom 56 passed on re-examination. This gives a percentage of 1·89 failures in colour vision, as against 1·51 in 1910, and is the largest proportion yet recorded. The methods of testing employed were the same as in 1910, the recommendations of the Departmental Committee appointed in that year not having yet been acted upon. Those recommendations included the substitution of a dark brown test skein for the deep red at present in use, and the employment of a special lantern, designed by the committee, for all candidates. Preparations are being made to carry these alterations into effect at the earliest possible time, and they seem calculated to meet all reasonable objections to the tests hitherto employed. An article on the report of the committee appeared in NATURE of July 4 (vol. lxxxix., p. 453).

VOL. v. of the Journal of the Municipal School of Technology, Manchester, a record of investigations published by the staff and students during 1911, extends to nearly 300 pages. Like its predecessors, it shows the unique position as a centre of research in applied science occupied by the Manchester School amongst the technical schools of this country. Three of the nineteen papers reprinted deal with pure science, and of them that by Prof. Gee and Mr. Adamson, describing a neat and simple "dioptriemeter" for measuring the focal lengths of lenses by the deviation produced, may be specially mentioned. Of the technical papers, the most important are that on electricity meters, by Messrs. Ratcliff and Moore, read before the Institution of Electrical Engineers, that on the electrical theory of dyeing, by Mr. W. Harrison, who finds in the theory explanations of many facts previously not interpreted, and that on boiler economics by the use of high gas speeds, by Prof. Nicholson, who shows how boilers may be reduced in size about 30 per cent. without any diminution in their steam production. The journal is printed in the printing crafts department of the school, and its execution does credit to that department.

UNDER the title of "Geostatic Funiculars," Prof. A. F. Jorini, writing in the *Rendiconti del R. Istituto lombardo*, xlv., 13, gives a solution of the problem presented by a cylindrical tunnel subjected to earth pressure, the surface of the superincumbent earth being horizontal.

PROF. C. MATAIX's papers on aëroplane stability in the *Revista de la Sociedad matemática española* conclude with the July number. The author succeeds in satisfying the conditions for longitudinal but not lateral stability. The latter failure is due to the character of the systems of surfaces assumed in the investigation. If the author had studied a system furnished with two vertical auxiliary surfaces or fins, he would have had no difficulty in satisfying the necessary conditions, and it is to be hoped that readers of the paper will not accept the conclusion that *all* systems of planes are laterally unstable.

IN a paper read recently by Mr. Edwin O. Sachs, at the New York International Congress on the testing of materials, the author directs attention to the very small amount of scientific testing of reinforced concrete which has been carried out in Britain. Our public institutions have been very remiss, for there is practically nothing to place beside the elaborate researches carried out by engineering professors in the public laboratories of the United States, Germany, and France. The author thinks that it is almost hopeless to expect our Government or our engineering colleges to pay now any attention to the matter, so that we can only look for a continuance of the efforts of private bodies, such as the professional societies intimately concerned.

OUR ASTRONOMICAL COLUMN.

GALE'S COMET, 1912*a*.—The comet discovered by Mr. Gale on September 8 is apparently becoming brighter and travelling northwards. A second telegram from Kiel states that it was observed at Santiago on September 11, when its position at 7h. 49·2m. (Santiago M.T.) was:—

R.A. = 13h. 54m. 2·4s., decl. = 33° 10′ 50″ S.

Comparing this with the position at the time of discovery, we see that the comet moved about 4° 15′ to the east and 3° 20′ northwards in a little more than two and a half days. In a telegram announcing the discovery, Reuter's Agency gave the magnitude as 6; the Santiago observer reports it as 5, so that there is a possibility of the comet becoming a more or less conspicuous object in our evening sky. When discovered, the comet was about half-way between θ and ι Centauri, and is apparently travelling towards the neighbourhood of α Libræ; this region now sets at about 7 p.m.

In the *Astronomische Nachrichten* (No. 4601) Herr Prager describes the object seen at Santiago as round, diameter 2′, magnitude between 3 and 6, nucleus, no tail.

THE TOTAL SOLAR ECLIPSE OF OCTOBER 10.—From *The Observatory*, No. 452, we learn that the eclipse party from Greenwich, consisting of Messrs. Eddington and Davidson, with Mr. J. J. Atkinson as a volunteer, left for Brazil on August 30. They expect to make their observations from Christina, some 150 miles inland from Rio de Janeiro, and the programme includes the direct photography of the corona, the photography of the ultra-violet spectra of the corona and chromosphere, and an attempt to secure monochromatic photographs of the corona in the light of the corona line (λ5303). The observing station is some 3000 feet above sea-level.

THE PERSEID SHOWER OF METEORS.—His watches for meteors on August 10 and 11 having disclosed but very meagre displays, Mr. Denning is led to believe that something must have intervened to bring about a very marked decline in the splendour of this noted shower. In a table, appearing in No. 452 of *The Observatory*, he shows how very few Perseids are now seen as compared with a decade ago. In 1901, during two watches of 6¾ hours in all, he saw 104 Perseids, in 1907 (6 hours) he saw 101, and in 1909 (4 hours) 79. Last year only three Perseids were seen in 2½ hours, while this year only fourteen rewarded his two watches of 2¼ and 1½ hours respectively. The conditions were not good, but, when compared with the 252 Perseids seen in 4 hours in 1874, and 285 in 5 hours in 1877, it would appear that something more than poor observing conditions must be held accountable for the poverty of recent displays.

THE SOLAR CONSTANT AND CLIMATIC CHANGES.—In a third paper on climate and crops, published in the Bulletin of the American Geographical Society for August, Mr. Henryk Arctowski compares the temperature records made at Arequipa during the period 1900–10 with the Washington values for the solar constant, and finds evidence of agreement between them; he also shows that Arequipa is not exceptional. His results indicate that a departure of 1° F. in the monthly mean observed at Arequipa is due to a departure, of about 0·015, of the solar constant from its normal value. If this be true, a comparatively small, but permanent, lowering of the constant would account for such climatical conditions as existed during the Pleistocene Ice age. Mr. Arctowski also finds that the oscillations of temperature found in his data correspond to those of atmospheric pressure to which Lockyer assigned a mean period of 3·8 years.

THE LEEDS ASTRONOMICAL SOCIETY.—The Journal and Transactions (No. 19) of this society for 1911 contains reports of a number of papers read before the society. Among others, there is an interesting discussion of the mutual eclipses of the satellites of Jupiter, by Mr. Whitmell, a paper dealing with suitable observations for amateur astronomers, by Mr. Ellison Hawks, and a discussion of the structure and sidereal significance of nebulæ by the Rev. Ivo Gregg. The membership now totals seventy-five, and the average attendance at meetings is fourteen.

THE PERIOD AND ORBIT OF α PERSEI.—From measures of a number of radial-velocity spectrograms, secured at the Potsdam Observatory between 1900 and 1908, Dr. A. Hnatek has derived an orbit for the spectroscopic binary α Persei, which he publishes in No. 4599 of the *Astronomische Nachrichten*. The variability of the velocity of this star, although small, now appears to be established, and Dr. Hnatek's results indicate a very short period of 4·0938 days. The radial-velocity of the system is −3·43 km., the eccentricity of the orbit 0·47, and the length of the semi-major axis of the projected orbit 46,000 km.

NEW RULES FOR LIFE-SAVING APPLIANCES IN BRITISH SHIPS.

MR. BUXTON has lost no time in considering and giving effect to the recommendations made by Lord Mersey and his colleagues, as well as the report of the Advisory Committee. The character of these recommendations and of that report has been described fully in previous issues (see NATURE, August 8 and 29); it will suffice, therefore, briefly to indicate the most important points in the Parliamentary Paper (Cd. 6402) issued a few days ago, in which the new rules made by the Board of Trade are contained. Those rules will not have statutory effect until they have lain on the table of the House of Commons for forty days, and it is not proposed that they shall come into effect until January 1, 1913. It is practically certain that when Parliament reassembles the rules will be criticised, and it is possible that they may be amended in some respects as the result of that criticism.

Although the rules previously issued have been accepted without serious challenge, the circumstances of the present revision and the drastic nature of some of the new regulations may cause a departure from precedent. Mr. Buxton has recognised the special conditions of the revision of the rules, and has wisely prefaced them by an explanatory memorandum which is both comprehensive and clearly expressed. His memorandum gives the history of the steps which have been taken by the President of the Board of Trade to deduce all possible lessons from the loss of the *Titanic* in order to secure greater safety in future for life and property at sea.

It is also, in effect, an attempt to justify the rules themselves in those features wherein the report of the Advisory Committee has been departed from. That report has been dealt with somewhat harshly by critics, who are disposed to think that shipowners serving on the committee have been unduly influenced by consideration of their class-interests. There is no real foundation for such an opinion, and Mr. Buxton marks his dissent therefrom by stating that, although he has been unable to adopt the conclusions of the committee on some material points, its report has been of very great value, and that he desires to express a high appreciation of the time "and pains expended by the members of the committee and of its various subcommittees on the important questions referred to them." Nothing but prejudice could lead to the conclusion that the shipowners and shipbuilders, who have given gratuitous and unstinting service on these inquiries, would have allowed personal considerations to weigh with them. On the contrary, it is clear that no classes of the community can have a greater interest in securing safety at sea, and certainly no other persons have done so much during the last twenty-five years to increase that safety.

The main point of difference between the Advisory Committee and the new official rules is to be found in the provision that foreign-going passenger and emigrant ships are in future to have sufficient *lifeboat* accommodation for all on board; whereas the committee recommended that lifeboats should be supplemented by rafts, collapsible boats, &c. It is intended further to consider the extent, if any, to which life-rafts may be used when the report of the Davits and Boats Committee—which is about to commence its labours—has been received. Collapsible boats are not to be included in future estimates of life-saving accommodation, although they may be continued in use in existing vessels for a certain period—not specified. On this point there will be debate, and there is reason for difference of opinion. Whatever the final decision may be, it should be noted that there is now universal agreement that in all cases, even in the best subdivided foreign-going ships, *every soul on board shall have a chance of keeping afloat* in boats, rafts, or other appliances, in case a ship founders through collision, grounding, or other accident. For ships in the home trade less stringent provisions are insisted upon in respect of life-saving accommodation, and this course is reasonable having regard to the restricted range of their employment and the greater chance of external help in case of accident.

What remains to be demonstrated—and the task will not be an easy one—is whether the large number of lifeboats now thought to be essential can possibly be so carried as to be loaded and got into the water safely within a reasonable time after an accident has taken place—say within half an hour or an hour. Judging by the *Titanic*—in which case all the circumstances were most favourable to the loading and lowering of boats—radical changes will be required in the installation of lifeboats and in the means of lowering them, if this essential condition is to be fulfilled. All that need be added is that whatever may be the number of lifeboats carried, and however efficient may be the details of the arrangements for lowering these boats, it is obviously of primary importance to secure efficient watertight subdivision in passenger ships, so as to minimise the risk of foundering and to lengthen out the time which ships will remain afloat in cases of accidents so serious as to involve their final sinkage. On this matter another committee is still at work, and no action can be taken by the Board of Trade until its report has been presented.

ATMOSPHERIC PRESSURE AND TEMPERATURE.

IN *Aus dem Archiv der deutschen Seewarte*, 1911, No. 4, W. Brockmöller discusses the geographical distribution of the monthly range of oscillation of the barometer. So far as the southern hemisphere is concerned, the question was thoroughly investigated by Dr. W. J. S. Lockyer in a recent publication of the Solar Physics Committee, but Herr Brockmöller's treatment of the subject covers a wider area, and is based on a different definition of the "range." He takes as the measure of this the mean value of the difference between the highest and lowest barometer readings for each month, and deals with a selection of stations, about 300 in all. After correcting the values for the periodic semi-diurnal variation, and for height above sea-level in the case of a few high-level stations, he plots the values for winter (December–February), and for summer (June–August), and obtains two very interesting charts, showing the isobarometric lines, or lines of equal range. For the northern hemisphere he obtains also normals for different latitudes, and draws the isanomalies, or lines of equal departure from normal. The range is least, 3 or 4 mm., in the equatorial region, and greatest near the arctic circle, apparently diminishing again towards the pole. The outstanding features are the maxima, in both seasons, near Iceland and the Aleutian Islands, the regions of the "permanent cyclones." The maxima are naturally much less intense in summer than in winter. Perhaps even more remarkable is the large value of the anomaly on the east coast of North America, where it is greater than at any other place. The effect is possibly due to the proximity of the division between the Labrador current and the warmer water of the North Atlantic, but it is deserving of further investigation.

In the same journal, No. 5, Prof. Köppen and Dr. Wendt discuss the vertical distribution of temperature over Hamburg between the earth's surface and a height of 3000 m. The records obtained in nearly 1200 ascents of kites and balloons during the years 1904–9 have been analysed very thoroughly, and a new departure has been made in the special treatment of so-called inversions of temperature-gradient. The authors find that such inversions occur in 69 out of every 100 ascents, the temperature remaining constant or increasing with altitude. Inversions are most frequent in autumn and winter, and in December they are found in nearly every ascent. At all seasons they occur most frequently with southerly winds. Inversions in which the increase of temperature exceeds 3° C. are almost invariably accompanied by a decrease in the relative humidity except for those which occur in the layer between the earth's surface and a height of 500 m. At all seasons the sky is more frequently cloudy than clear on the occasions when inversions are recorded, but in spring and autumn the number of cases of clear sky is large. The clouds were found usually to have their lower surfaces below 500 m., *except in those cases in which inversions occurred below* 500 *m.* Another section of the paper deals with the dependence of temperature-gradient on wind direction. Near the surface the gradient is greatest with N. winds, above 500 m. with W. winds, and above 1000 m. with S.W. winds. As the wind usually veers with increasing height, it seems probable that the actual direction of the current for maximum gradient in the layer considered will be northerly at all heights.

PLANKTON INVESTIGATIONS.

IN the *Bulletin Trimestriel*, 1911, the second part of the "Résumé des Observations" continues the summary of the plankton investigations carried out under the international programme in the north-east Atlantic and north-west European waters during the years 1902–8. The subjects here dealt with are the Copepoda, Tunicata, Ostracoda, Chætognatha, Amphipoda, Rotatoria, and Ceratium. With the vast amount of material collected in course of the investigations external records are incorporated in a discussion of the seasonal occurrence and distribution of the species considered, and the hydrographic conditions associated in each case with such. The annual and seasonal distribution and intensity of many of the more important species are shown in a number of separate charts. From an economic point of view, attention is directed to the importance of many of the Copepoda and Amphipoda as constituting in a large measure the food supply of Clupeoids, Gadidæ, the mackerel, and other marketable fishes.

As bearing directly on questions of physical oceanography, Salpa and Doliolum among the Tunicata afford important examples of warm-water species drifted as annual visitors to our coasts by the agency of the Gulf Stream. Similarly, several species of Ceratium show a distribution largely increased by immigration through the Faroe-Shetland Channel into the North and Norwegian Seas and beyond. Some of the latter species have a second sphere of distribution in the West Atlantic, from Florida to Newfoundland, and the author of this section, who has traced some of them sparingly at wide intervals across the Atlantic to the American coast, is of opinion that the two spheres of distribution are indeed in communication by virtue of the east-going oceanic movement. Conversely, among the brackish-water Rotatoria, species find their extension during the summer months from the Gulfs of Finland and Bothnia over the Baltic and outwards, mainly dependent on the periodic surface outflow of low-salinity water in this region. For the further elucidation of these complex problems, more exact information is required concerning some of the more critical species, and the need is felt, in particular, for a greater extension of the area of investigations to the westward and south-westward of Ireland.

THE PLACE OF MATHEMATICS IN ENGINEERING PRACTICE.[1]

THE foundations of modern engineering have been laid on mathematics and physical science; the practice of engineering is now governed by scientific methods applied to the analysis of experience and the results of experimental research. Engineering has been defined as "the art of directing the great sources of power in nature for the use and convenience of man." An adequate acquaintance with the laws of nature, and obedience to those laws, are essential to the full utilisation of these sources of power. It is now universally recognised that the educated engineer must possess a good knowledge of the sciences which bear upon his professional duties, in combination with thorough practical training and experience in actual engineering work. Neither side of his education can be neglected without hampering him seriously, especially when he has to go beyond precedent and face new problems. Of these sciences, the mathematical is undoubtedly of the greatest importance to engineers. The range and character of mathematical knowledge which can be considered adequate are gradually being agreed upon as experience is enlarged; and present ideas are embodied in the courses of study prescribed in the calendars of schools of engineering. Absolute identity in the course of study and the standards laid down for degrees in engineering has not been attained, but the approach thereto has already been considerable, and the movement will undoubtedly continue in the same direction.

The preponderance of opinion amongst engineers now favours the teaching to students of engineering of science generally, and of mathematics in particular, being undertaken by recognised authorities in the several branches, and on lines which shall ensure greater breadth of view and fuller capability for dealing with new problems arising in their professional work than can be secured by means of special courses of instruction arranged for students of engineering as a class apart. Whatever branch of engineering a man may select for his individual practice, he must need a fundamental knowledge of mathematics, and in some branches, in order to do his work well, he will require to add considerably to the mathematical knowledge which is sufficient for a degree.

As time passes the mathematician and the practising engineer have come to understand one another better, and to be mutually helpful. While engineers as a class cannot claim to have made many important or original contributions to mathematical science, some men trained as engineers have done notable work of a mathematical character. The names of Rankine, William Froude, and John Hopkinson among British engineers also hold an honoured place in mathematics. Mathematicians of eminence have spent their lives in the tuition of engineers, and in that way have greatly influenced the practice of engineering; but while they have necessarily become familiar with the problems of engineering as a consequence of their connection therewith, they have not accomplished much actual engineering work, and none of it has been of first importance. Speaking broadly, there is an abiding distinction between mathematicians and engineers. Mathematicians regard engineering chiefly from the scientific point of view, and are primarily concerned with the bearing of mathematics on engineering practice, the construction of theories, and the framing of useful rules. Engineers, even when well equipped with mathematical knowledge, are primarily devoted to the design and construction of efficient and durable works, their main object being to secure the best possible association of efficiency and economy, and so to achieve practical and commercial success. There is evidently room for both classes, and their collaboration in modern times has produced wonderful results.

The proper use of mathematics in engineering practice is now generally agreed to include the following steps: first comes the development of a mathematical theory based on assumptions which are thought to embody and to represent conditions disclosed by past practice and observation. Frequently these theoretical investigations give rise to valuable suggestions for further observation or experimental investigations. Mathematical analysis must be applied to the results of observation and experiment; and, as a result, amendments or extensions are made of the original mathematical theory. Useful rules are also devised, in many instances, which serve for guidance in the future practice of engineers. Formerly it was thought by men of science that purely mathematical investigation and reasoning would do all that was required for the guidance of engineering practice; now it is admitted that such investigations will not suffice, and that the chief services which can be rendered to engineering by mathematicians will consist in the suggestion of the best directions and methods for experimental research, the conduct of observations on the behaviour of existing works, the establishment of general principles based on analysis of experience, and the framing of practical rules embodying scientific principles.

The contrast between present and past methods can be illustrated by comparing investigations made during the eighteenth century into the behaviour of ships amongst waves by Daniel Bernoulli, who won the prize offered by the Royal French Academy of Science in 1757, and work done by William Froude a century later in connection with the same subjects. Bernoulli was the greater mathematician, but had only a small knowledge of the sea and of ships. His memoir was a mathematical treatise; his practical rules, although deduced from mathematical investigations which were themselves correct, depended upon certain fundamental assumptions which did not correctly represent either the phenomena of wave-motion or the causes producing and limiting the rolling oscillations of ships. Bernoulli realised and dwelt upon the need for further experiment and observation and showed remarkable insight into what was needed; but the fact remains that he neither made such experiments himself nor was able to induce others to make them. As a consequence, his practical rules for the guidance of naval architects were incorrect and would have produced mischievous results if they had been applied in practice.

William Froude was a trained engineer who had a good knowledge of mathematics and a mathematical mind. His acquaintance with the sea and ships was considerable, his skill as an experimentalist was remarkable, and he was fortunate enough to secure the support of the Admiralty through the Constructive Department. He thus obtained the services of the officers of the Royal Navy in making a long series of accurate and detailed observations of the characteristic features of ocean waves as well as the rolling of ships amongst waves or in still water. In this way, starting with the formulation of a mathematical theory of wave-motion, and of a theory for unresisted rolling in still water and amongst waves, Froude added corrections based on experimental research, and succeeded eventually in devising methods by means of which naval architects can make close approximations to the probable behaviour of ships of new design when exposed to the action of waves,

[1] Lecture delivered at Cambridge before the Fifth International Congress of Mathematicians by Sir William H. White, K.C.B., F.R.S.

either forming a regular series or constituting an irregular sea. In these approximations allowance can be made for the effect of water-resistance to the rolling motion—a most important factor in the problem which could not be dealt with until experimental research had been made, and results had been subjected to mathematical analysis. In addition, Froude laid down certain practical rules for the guidance of naval architects, and the application of these rules has been shown by long experience to favour the steadiness—that is to say, the comparative freedom from rolling—of ships designed in accordance with these rules. In short, a problem which had proved too difficult when attacked by Daniel Bernoulli in purely mathematical fashion was practically solved a century later by Froude, who employed a combination of mathematical treatment and experimental research.

Another example of the contrast between earlier and present methods is to be found in the treatment of the resistance offered by water to the onward motion of ships. From an early date mathematicians have been attracted to this subject, and many attempts were made to frame mathematical theories. When steam-propulsion for ships was introduced, the matter became of great practical importance, because it was necessary to make estimates for the engine-power required to drive a ship at the desired speed. In making such estimates it was necessary to approximate to the value of the water-resistance at that speed, although the required engine-power was also influenced by the efficiency of the propelling apparatus and propellers. In addition, it was obvious that the water-resistance to the motion of a ship when she was driven by her propellers at a given speed would be in excess of the resistance experienced if she were towed at the same speed, and there was no exact knowledge in regard to that increment of resistance. The earlier mathematical theories of resistance proved to be of little or no service, and they were based on erroneous and incomplete assumptions. Rankine devised a "stream-line" theory which was superior to its predecessors, but it also for a time had no effect on the practice of naval architects. William Froude, adopting this stream-line theory, dealt separately with frictional resistance, and devised a "law of comparison" at corresponding speeds, by which from the "residual resistance" of models—exclusive of friction—it became possible to estimate the corresponding residual resistance for ships of similar forms. At first he stood alone in advocating these views, but subsequent experience during forty years has demonstrated their soundness.

Experimental tanks for testing models of ships, such as Froude introduced, are now established in all maritime countries, and the results obtained therein are of enormous value to the designing of steamships. In regard to the selection of the forms of ships, naval architects are now able to proceed with practical certainty; but in connection with the design of screw propellers, even after model experiments have been made with alternative forms of screws, there is still great uncertainty, and dependence upon the results obtained on "progressive" speed trials of ships is still of the greatest service. As yet the "law of comparison" between model screws and full-sized screws has not been determined accurately. The condition of the water in which screws act, as influenced by the advance of a ship and her frictional wake, the phenomena attending the passage of the water through a screw, and the impression thereon of sternward motion from which results the thrust of the propeller, the effect upon that thrust of variations in the forms and areas of the blades of screw propellers, and the causes of "cavitation," all form subjects demanding further investigation. In these cases the only hope of finding solutions lies in the association of experimental research with mathematical analysis. There have been very many mathematical theories of the action of screw propellers, but none of these has provided the means for dealing practically with the problems of propeller design, and there is no hope that any purely mathematical investigation ever will do so, because the conditions which should be included in the fundamental equations are complex and to a great extent undetermined.

In connection with other branches of engineering, model-experiments have also proved effective. Examples are to be found in connection with the estimates for wind-pressure on complicated engineering structures, such as girder or cantilever bridges. Experimental methods are also being applied with great advantage to the study of aeronautics and the problems of flight.

The association of the mathematical analysis of past experience with designs for new engineering works of all kinds is both necessary and fruitful of benefits. A striking example of this procedure is to be found in connection with the structural arrangements of ships of unprecedented size, which have to be propelled at high speeds through the roughest seas, to carry heavy loads, to be exposed to great and rapid changes in the distribution of weight and buoyancy, and to be subjected simultaneously to rolling, pitching, and heavy motion, as well as to blows of the sea. In such a case purely mathematical investigation would be useless; the scientific interpretation of past experience and the comparison of results of calculations based on reasonable hypotheses for ships which have seen service with similar results of calculations for ships of new design are the only means which can furnish guidance.

In the past the association of mathematicians and engineers has done much towards securing remarkable advances in engineering practice; and in future it may be anticipated that still greater results will be attained now that the true place of mathematicians in that practice is better understood and utilised.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

A GREAT cause of anxiety to those who are responsible for evening continuation schools and classes lies in the spasmodic attendances and lack of continuity of the casual student. The prospectus of the Municipal Technical Institute, Belfast, shows that the authorities in that city deal with this source of trouble courageously. Students must submit to an entrance examination, and must follow a course of study, and "any student who does not wish to conform to the regulation as to attending a definite course of study or passing the entrance examination can obtain exemption on making application at the office and paying *treble* the fee for the class it is desired to join." Side by side with these restrictions there is every opportunity and incentive to the serious student to equip himself thoroughly for his business.

THE London County Council announces that the evening classes held in Polytechnics, technical institutes, schools of art, commercial centres, and evening schools will shortly be reopened. The programme which the Council has prepared includes classes to meet all kinds of needs. The enrolment of students began on Monday, September 16, and a leaflet giving full particulars as to where the classes are held, and as to fees (which it may be stated are very low), can be obtained at any of the Council's schools and of the Education Officer, Education Offices, Victoria Embankment. It is hoped that the efforts of the Council to improve the education of the young people of London by means of these valuable classes will result in a large influx of new and earnest students in the session now at hand.

The 90th session of the Birkbeck College will commence on Wednesday, September 25. The opening address will be given in the theatre at 7.30 p.m., by Sir Sidney Lee. The class-rooms, &c., will afterwards be open for inspection, and there will be an exhibition in the Art School. The college is conducted in relation with the University of London; classes are held both in the day and evening; twenty-nine members of the staff are recognised teachers of the University. There is a very complete curriculum for chemistry, physics, mathematics, botany, zoology, and geology. The laboratories are well equipped with modern apparatus and appliances, and research work is encouraged in all the science departments. According to the calendar more than 118 students passed some examination of the University during the last session: forty-nine took degrees in arts or science, twenty-two with honours, and several students gained distinction at other universities.

The new session of the Battersea Polytechnic opened on Tuesday, September 17, and the calendar gives full details of all the numerous courses and classes held at the Polytechnic. In the Day Technical College full-time courses are arranged in mechanical, civil, electrical and motor engineering, architecture and building, chemical engineering, and art, the courses covering a period of three years, at the end of which time students passing the necessary examinations are awarded the Polytechnic diploma. There are also full university and diploma courses in mathematics, physics, chemistry, botany, &c. Concurrently with the diploma courses, students can prepare for and take the degree courses in science and engineering of the University of London. In the electrical engineering department, a new course in electric lighting and illumination will be held during the second term of the session. The greatest development to be recorded this year is in the department of natural science, *i.e.* including the subjects of hygiene, physiology, geology, and bacteriology. The recent donation of 6000*l.* made by the Worshipful Company of Drapers has enabled the governing body to erect a four-storey building for the housing of the above sections of work, and thus airy and well-lighted laboratories and lecture-rooms of the latest design, and fitted with the most modern equipment, are now available for this most important work.

An influentially signed appeal has reached us for support to a scheme for providing a systematic course of combined military and industrial training for lads from the age of fourteen years upwards. The object of the British Boys' Training Corps, on behalf of which the appeal is made, is the moral, physical, and industrial advancement of the cadets enrolled in it, to train them in the duties of citizenship, and to fit them for a life of industry. Military organisation and exercise will be used as a means for developing their *moral* and physique, and promoting among them habits of discipline, application, adaptability, and resourcefulness, which are indispensable to proficiency in the workshop or the factory. The corps will, in effect, be a military and industrial boarding-school, and is designed to train and instruct a boy for a period of three or four years continuously from the time he leaves the elementary school. Alike upon social, economic, and industrial grounds the scheme is commended to the public. The annual loss to the nation of promising material presents a grave problem. Far too many boys on leaving school are engaged in "blind-alley" occupations; when they have outgrown these, they find themselves adrift without either the skill or the knowledge to qualify them for permanent employment; they swell the ranks of casual labour, and the prison or the workhouse is the ultimate destiny of an increasing number of them. To mitigate these evils in some measure at least is the aim of the corps. It is estimated that the cost of establishing and maintaining the corps at first will be 15,000*l.* No appeal for funds has hitherto been made, but two members of the council have generously promised to guarantee 1000*l.* and 500*l.* respectively towards the expenses on condition that the total amount guaranteed or subscribed is not less than 15,000*l.*, and various unsolicited donations, including an anonymous one of 50*l.*, have already been placed to the credit of the corps at the Bank of England. Guarantees, donations, or subscriptions may be sent to the account of the corps at the Bank of England (Western Branch), Burlington Gardens, W.; to Colonel Pollock, Wingfield, Godalming; or to the hon. secretary, Mr. J. C. Medd, 37 Russell Square, W.C., from whom particulars of the scheme can be obtained.

SOCIETIES AND ACADEMIES.

Paris.

Academy of Sciences, September 2.—M. P. Appell in the chair.—A. **Lacroix**: The origin of the transparent quartz of Madagascar. The hyaline quartz of Madagascar is of complex origin, but there are only two classes of deposits furnishing the mineral in large quantities and of sufficient transparency for industrial purposes. One of these is in lodes of the Ampangabé type, in which the quartz is without crystalline form; the other is of hydrothermal origin, and here the quartz forms well-defined crystals.—A. **Riccò**: Filaments, *alignements*, and solar prominences. The author confirms the view that there is a relation between the prominences and the filaments and *alignements*.—Jean **Danysz** and William **Duane**: The electrical charges carried by the α and β rays. From the experiments described the electrical charge carried by the α rays of one Curie of emanation in equilibrium with radium A, B, C is deduced as 90·8 electrostatic units per second, or nearly three times the charge found by Rutherford for radium C alone in equilibrium with one Curie of emanation. From this constant are deduced the volume of one Curie of emanation (0·595 mm.^{3} at 15° C.), and the volume of helium given off by one gram of radium in equilibrium with its emanation and radium A, B, and C (157 mm.^{3}), both in good agreement with the experimental values.—Victor **Henri** and René **Wurmser**: Study of the law of photochemical absorption for reactions produced by the ultra-violet rays. There is a striking parallelism between the absorption curve of acetone in the ultra-violet and the chemical activity of the different rays. This reaction affords an example where the extreme ultra-violet rays are less active chemically than ultra-violet rays of greater wave-length.—Claude **Verne**: *Solanum maglia* and *tuberosum*, and the results of experiments on cultural bud mutations undertaken on these wild species of potato.—H. **Busquet**: The comparative cardiac action of the physiological extract of digitalis and other digitalis preparations.—Romuald **Minkiewicz**: *Ciliata chromatophora*, a new order of Infusoria with unusual morphology and reproduction.—C. **Maltézos**: Contribution to the phenomena of lightning.

September 9.—M. P. Appell in the chair.—A. **Müntz**: The evaporation of the soil and of plants as a factor in causing the persistence of wet and cold weather.—Daniel **Berthelot** and Henry **Gaudechon**: The action of the ultra-violet rays upon gaseous hydrocarbons. Remarks on a recent note by Marc Landau.—Em. **Bourquelot** and M. **Bridel**: A new synthesis of the glucoside of an alcohol with the aid of emulsin. β-Benzylglucoside.—Ch. **Jolin**: The specific histological characters of the "luminous cells" of *Pyrosoma giganteum* and of *Cyclosalpa pinnata*.

NEW SOUTH WALES.

Linnean Society, July 31.—Mr. W. W. Froggatt, president, in the chair.—Rev. W. W. **Watts**: The ferns of Lord Howe Island. During a two months' stay, last year, Mr. Watts collected specimens of the unique fern-flora of the island. The paper indicated the species to be found on the northern hills, in the central area, and at the southern end of the island, where Mts. Lidgbird and Gower rise to a height of 2500 and 2800 ft. respectively. The plateau on the top of Mt. Gower is the home of a number of beautiful species to be found nowhere else.—R. J. **Tillyard**: Some new and rare Australian Agrionidæ (Neuroptera: Odonata). In this paper, a considerable number of new Australian species are described, and new genera are proposed for the reception of these and other species.—H. J. **Carter**: Descriptions of some new species of Coleoptera.

BOOKS RECEIVED.

Manuale di Fisica ad uso delle scuole secondarie e superiori. By Prof. B. Dessau. Volume Primo. Meccanica. Pp. xii+500. (Milano: Società Editrice Libraria.) 12 lire.

Mysore Geological Department. Report of the Chief Inspector of Mines for the Year 1910–11. With Statistics for the Calendar Year 1910. (Bangalore: The Government Press.) 2 rupees.

Practical Chemistry, including Simple Volumetric Analysis and Toxicology. By Prof. P. A. E. Richards. Second Edition. Pp. x+149. (London: Baillière, Tindall and Cox.) 3*s*. net.

Handwörterbuch der Naturwissenschaften. Edited by E. Korschelt and others. Lief. 14–18. (Jena: G. Fischer.)

Index of Economic Material in Documents of the U.S. Ohio, 1787–1904. Parts i. and ii. By A. R. Hasse. Pp. 1136. (Washington: Carnegie Institution.)

Department of Commerce and Labour. Coast and Geodetic Survey. Results of Observations made at the Coast and Geodetic Survey Magnetic Observatory at Vieques, Porto Rico, 1909 and 1910. By D. L. Hazard. Pp. 94+10 diagrams. (Washington: Government Printing Office.)

Modern Sanitary Engineering. By G. Thomson. Part i., House Drainage. Pp. xv+266. (London: Constable and Co., Ltd.) 6*s*. net.

The World's Cane Sugar Industry, Past and Present. By H. C. P. Geerligs. Pp. xvi+399+plates+maps. (Altrincham: N. Rodger.) 12*s*. net.

The Origin and Evolution of Primitive Man. By Dr. A. Churchward. Pp. 88+46 plates. (London: G. Allen and Co., Ltd.) 5*s*. net.

Science French Course. By C. W. P. Moffatt. Pp. x+305. (London: W. B. Clive.) 3*s*. 6*d*.

Home University Library:—The Human Body. By Prof. A. Keith. Pp. 256. The Making of the Earth. By Prof. J. W. Gregory. Pp. 256. Electricity. By Prof. G. Kapp. Pp. 256. (London: Williams and Norgate) Each 1*s*. net.

Bacon's New Globe, with Contour Colouring. (London: G. W. Bacon and Co., Ltd.) 25*s*. net.

British Plant-galls. By E. W. Swanton. Pp. xv+287+32 plates. (London: Methuen and Co., Ltd.) 7*s*. 6*d*. net.

Spiderland. By P. A. Ellis. Pp. xxii+108. (London: Cassell and Co., Ltd.) 3*s*. 6*d*. net.

Malta and the Mediterranean Race. By R. N. Bradley. Pp. 336. (London: T. F. Unwin.) 8*s*. 6*d*. net.

New South Wales. Historical, Physiographical, and Economic. By A. W. Jose, T. G. Taylor, and Dr. W. G. Woolnough. Edited by Prof. T. W. E. David. Pp. xii+372. (Melbourne: Whitcombe and Tombs, Ltd.) 4*s*. 6*d*.

Dizionario di Merceologia e di chimica applicata. By Prof. V. Villavecchia, Dr. G. Fabris, Dr. G. Rossi, and Dr. A. Bianchi. Terza Edizione. Vol. ii. Pp. 1360. (Milano: Hoepli.) 15 lire.

Bartholomew's New Reduced Survey Maps for Tourists and Cyclists. Sheet 9, Berwick and Haddington. Sheet 21, Inverness and Spey. (Edinburgh: J. Bartholomew and Co.) Each 1*s*. 6*d*. net.

CONTENTS.