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Festivals and Survivals.

ELSEWHERE in this issue we publish the first of a series of brief notes on the calendar, which will appear from week to week in the coming year. These notes will deal with the principal fasts, feasts, and festivals of the Christian year, referring especially to the traditions, the customs, and the usages which are or have been associated with them. When possible, attention will be directed to similar observances in religions other than the Christian where these present analogies to, or serve to throw light upon, the origin and meaning of religious tradition. It is by the citation of such parallels that much in popular belief and custom, which those who in the past were curious in such matters thought merely quaint or inexplicable, has been shown to be a survival of a primitive mode of thought and a corresponding ritual. In his monumental works on early forms of religion, Sir James Frazer has interpreted the meaning of many of these periodic and seasonal observances, and he has interpreted them in such a way as to throw light on their significance in relation to the lowly as well as more highly organised beliefs. Throughout the "Golden Bough," in examples drawn from the beliefs and practices of Christian and pagan alike, there runs the central theme of the doctrine of atonement, of the sacrifice of a deity incarnate in man or animal, of the victim offered up for the salvation of the community, whether it be a community of worshippers or of subjects, and sometimes of both.

Although the more primitive peoples of to-day as we know them may be by no means so unsophisticated as they are held to be in popular belief, yet in the simpler societies the primal springs of action are more readily to be discerned. In the more complex civilisations of advanced races they are overlaid and obscured by tradition, convention, and sentiment. In all alike, however, from the lowest to the highest, in the ultimate analysis the fundamental urge is directed towards the preservation of the individual and the race. In some cases the two may conflict, as they did in the opposition of the spiritual and the material in the monasticism of the Middle Ages: in extremes both may be ignored. Given these fundamental motives in conjunction with the primitive animistic interpretation of Nature, on one side there arises from the magical ideas connected with the organs of reproduction and their function, an abhorrence of a contravention of sexual regulations in combination with a periodic unrestricted licence of orgiastic rites; on the other, many and various means are brought into operation,

especially at certain seasons of the year, to promote the fertility and prosperity of the stock or crops, and to ensure the preservation and increase of the food supply. The sexual licence of a normally strict society finds its analogy in the sacrificial rite or ceremonial meal which, it has been found, at times and with some peoples, ignores the taboo of the sacred animal. Nor is it enough thus to enhance actively the forces of Nature; the individual and the group must be protected from the influence, more often malign than benignant, of the spirits, whether they be conceived as of the deities or of the dead. Hence the propitiatory rites, the funerary ceremonies, and the various means taken to drive away or ward off spirits and the ghosts of the departed. These dimly survive even to-day. All Hallow-e'en is the Feast of the Dead; we still carry the dead man from the house feet first that he may not return.

In a community as that of the British Isles, which for the greater part of its history has been predominantly dependent upon agriculture, it should not be unexpected to find customs which point to a survival of these primitive ideas. Many of the customs of the 'harvest home' are to the ordinary observer now meaningless; but when, for example, as the last load is brought in, the men are drenched with water by the women waiting for them, the rainfall which will bring fertility in the future is ensured. When in some remoter parts a few stalks of corn are still fastened together in something of the semblance of a human figure or 'dolly,' it recalls the time when the precious seed was preserved for the following season by being regarded as a material form of the deity, and invested with all his sanctity. If it were possible to attain a position of complete philosophical detachment, it would not be far-fetched to regard the mystic communion of those who partake of a ritual meal of the first fruits of the grain, which embodies the spirit of the corn, or of the sacrificial victim in the religious rites of some primitive tribe and of those who hold the extreme doctrines of the sacrament as one and the same. To-day in Italy a blend of paganism and Christianity sets up in a field after the harvest has been taken twelve little corn figures around a thirteenth, representing in the traditional form of the corn spirit our Lord and the Twelve Apostles.

The election of a King or Lord of Misrule on Twelfth Night goes back far beyond the *Saturnalia*, with which it is usually compared, to their common origin in the ritual unrestraint of some primitive fertility rite. In even more dramatic form the folk dance 'gathering peascods' ensures magically a full crop by the simulation of gathering it, and the Durham sword dance perpetuates the slaughter of the king to secure in a younger successor the vigour of the community. The Abbots Bromley horned dance may date from an even remoter time when members of a hunting community wore, not ash branches, but antlers on their heads to represent the deer, thus securing the food supply by a ceremonial representation of their prey. The Witches' Sabbath, obviously a perverted fertility rite, also may go back beyond the agricultural to a pastoral stage with a six- instead of three-monthly division of the year at spring and autumn, as well as enshrine the memory of a ritual cannibalism not entirely due to a morbid popular imagination.

It is not surprising that in the earliest days of the Christian Church a rigid abstention from the rites of paganism was required of believers, an abstention they frequently failed to observe. Civic duties under Roman rule or in a community largely Greek entailed performance of, or participation in, a ceremonial involving religious elements. Further, in an eastern population of mixed races and religions, the desire to take part in a general merry-making is sometimes apt to overshadow differences of belief. The early Christians were forbidden even to join in the custom of an interchange of gifts on the Kalends of January; but how strong was the hold of the old gods is seen in the perpetuation of the Mother Goddess and the Veiled Artemis in the Madonna; the medieval devil still shows the cloven hoof of Pan and the horns of the woodland deities.

When the puritanical aloofness of the early Christians gave way in self-defence to a spirit of compromise, the Christian feasts and fasts were made to agree in time with those of paganism or of the old dispensation. The celebration of the birth of Christ was fixed at about the winter solstice, the time of the great feast of the god Mithra, while the Crucifixion and the Resurrection fell at the celebration of the Passover and the spring festival of other oriental religions. It was the duty of the high priest to fix the date of the Passover from observation of the moon's phases: the Church still fixes the date of Easter in relation to the same phenomenon. The coincidence of these festivals did not escape the notice of the ancients themselves, and the followers of Mithra accused the Christians of having copied their rites, while a like accusation was brought against them by the Christians. It must also be remembered that, owing to their racial inheritance and their social environment, the early Christians did not differ essentially in mentality from their fellows. However far apart they stood from them

in form of observance and theological doctrine, their fundamental religious ideations had not yet diverged much from those of their contemporaries.

Traces of this relationship can be seen in the theological discussions within the Church to quite a late date. Purely magical ideas abound in the writings of the Fathers and the lives of the Saints. Much of medieval and still later belief—witness the doctrine of witchcraft—is essentially primitive. Mathew Hopkins, the Essex witch finder, who swam a witch or weighed her against the Parish Bible, differs in method but not in kind from the South African witch doctor who 'smells out' a witch by 'throwing the bones.' Witchcraft was not merely a popular superstition. Even in the seventeenth century, belief in the witch to many was a test of orthodoxy, while the doctrines of the Council of Trent contain elements which are of the purest animism, at least in form, however theological interpretation may now attempt to explain them away.

The reason for the persistence of a primitive mode of thought which we now look upon as alien to the true spirit of Christianity is not far to seek. In the spread of Christianity, however strong the denunciation of paganism, a certain toleration and adaptation was the practice. This was inevitable, especially in the later days of missionary effort, when a prince and all his people might be baptised *en masse* on one day. It was impossible that every individual, or even that any considerable number, had already been personally convinced of his or her theological error and instructed in Christian doctrine. Consequently, in the remoter parts, such as Britain, Scandinavia, Central Europe, a mass of pagan beliefs and observances survived under the ægis of Christianity. Slowly and very gradually, as in succeeding ages an increasing number of individuals of stronger intellectual calibre have emancipated themselves from the trammels of tradition, ritual, and belief has been purged. But in remoter districts, in the Balkans, in Russia, among all the peasant populations of Europe, they linger to-day. In the British Isles most of them have vanished, but here and there traces of a forgotten belief still remain, while of what is lost something has been recorded by gleaners of these survivals of an older faith.

The succession of racial migrations and invasions which the British Isles have witnessed has superimposed culture upon culture. These the archæologist, the ethnologist, and the folklorist seek to recover and differentiate. For this purpose the festivals of the calendar are one of the most fruitful sources. The ritual observances of a primitive people being associated with their chief preoccupation, the conservation of the food supply and the propitiation of the deified forces of Nature, centre around certain crucial seasons of the year, seed time and harvest, the summer and winter solstice, and the spring and autumn equinox. Transformed and degraded, their meaning forgotten, they survive in association with certain days and seasons in the Christian calendar. So beneath our Christmas lies the Saxon Yule. A saint's day may hide the festival of a Celtic goddess.

The Flow of Water.

(1) *Stream Gaging.* By William Andrew Liddell. Pp. xiv + 238. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1927.) 15*s.* net.

(2) *Hydraulics.* By Prof. Ernest W. Schoder and Prof. Francis M. Dawson. Pp. xvi + 371. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1927.) 17*s.* 6*d.* net.

(3) *Hydraulics: a Text-book covering the Syllabuses of the B.Sc. (Eng.), A.M.Inst.C.E., and A.M.I.Mech.E. Examinations in this Subject.* By E. H. Lewitt. (Engineering Degree Series.) Pp. xii + 372. (London: Sir Isaac Pitman and Sons, Ltd., 1927.) 10*s.* 6*d.* net.

(4) *Modern Waterworks Practice.* By F. Johnstone Taylor. Pp. 272. (London: Ernest Benn, Ltd., 1927.) 18*s.* net.

THE control of water is one of the oldest branches of civil engineering, and to-day problems connected with the flow of fluids are of first importance in connexion with many scientific and technical activities. Like the engineers of ancient times, the modern engineer has to control the flow of water in canals and aqueducts; where they constructed small reservoirs, he constructs to-day reservoirs of very great capacity. The ancients drew water from shallow wells by primitive means; the engineer to-day uses deep well power-driven pumps to draw water from strata hundreds of feet below the surface of the earth. For thousands of years the power of flowing streams has been utilised to work simple machines, but to-day the rains that fall on the mountain areas are directed into channels that convey the water to machines developing tens of thousands of horse-power.

So important has a knowledge of the laws governing the control and flow of fluids become, that in the training of students of nearly all branches of engineering the subject of hydraulics, embracing the fundamental principles of hydro-

statics, the flow and measurement of water and other fluids, the design of machines for the pumping of water and for the utilisation of water as a source of energy, form part of the curriculum. It is not surprising, therefore, that there is a growing body of literature dealing with particular branches of the subject, as well as with the fundamental principles of hydraulics. Of the four volumes before us, only the first can be said to meet a real need; the two books on hydraulics contain very little that cannot be found just as clearly and more logically developed in other books on the subject.

(1) Stream gauging has become a subject of real significance in the economic life of most countries. The United States, from which the first book comes, and the Dominion of Canada have for a number of years been engaged in a hydrographic survey of the water available in the natural streams, and very valuable data have been gathered as to the sources of power available, and the water available for irrigation, domestic, and manufacturing purposes. In Great Britain a good deal has been done, but in this country and in other parts of the British Empire much remains to be done, and this work, dealing with American experience, should be useful to students and to engineers concerned in the gathering and utilisation of data.

Two preliminary chapters deal with the general principles of the flow of water in open channels in an elementary way, no attempt being made to justify usually accepted formulæ. In the third chapter, experimental curves (determined by Darcy and other workers) of distribution of velocity in the sections of open channels are considered; the shape of the velocity curve on a vertical section is fully discussed, and methods suggested for finding the mean velocity on a vertical section. Gauging stations and the methods of gauging streams and analysing the results are described in detail. The defectiveness of the current meter in determining small velocities is rightly emphasised, and the student is warned of the care necessary to obtain reasonably accurate results from such instruments. The last chapter of the book deals with a subject not of great importance in Great Britain but of very great importance to Canada; the effects of ice on stream flow and on the form of the velocity curves for ice-covered streams become of very great importance when a stream is required for hydroelectric power production. An appendix is attached of fifty-two well-selected problems relating to the gauging of streams. The work forms a useful addition to the literature of an important engineering and economical subject.

(2) and (3) Both the volumes on hydraulics are written for the student. That by Schoder and Dawson claims to have been written, however, "in the atmosphere of engineering activities." This volume contains matter that is found in other works on hydraulics, but, quite consistently with the real aim of the subject, it only deals with continuous flow, whether in machines or other appliances. No reference is made to the hydraulic press or crane, or to reciprocating hydraulic engines and pumps. The first three chapters deal with hydrostatics and flotation. The flow of fluids through orifices is dealt with in a simple but somewhat empirical manner; there is a lack of logical development and authorities are not quoted. Useful data and references relative to submerged orifices and short tubes are, however, given.

The general impression given by the book is that students in the United States approach technical subjects with insufficient mathematical preparation; otherwise it would scarcely be necessary to give detailed instruction as to how the value of $v^2/2g$ can be obtained by means of a slide rule. The authors appear to be fearful of assuming that readers have an elementary knowledge of the fundamental principles of mechanics, and write a good deal on the flow of fluids before mentioning Bernoulli's theorem. On the other hand, the authors plunge into the use of the calculus immediately, in the chapter on flow over weirs, and use it to deduce the flow over a rectangular weir and a V notch in a manner which James Thomson and Prof. Perry years ago thought was entirely unjustifiable. It is an abuse of mathematics to integrate over an area in which the conditions do not even approximate to those assumed in the mathematical analysis. The remaining chapters dealing with flow in pipes and channels and with centrifugal pumps and turbines call for no particular comment. It is of interest to find a chapter dealing with flow of oil and gases in pipes. Reynolds's work and the criterion for similarity vd/ν is referred to, but this is not developed very far.

The book by Lewitt bears much more the stamp of a work specially written with the examination in view, and the whole impression gathered from reading the book is that the least amount of critical study possible has been given to the subject. The only excuse, perhaps a laudable one, is that of dealing with as much as possible in a half-guinea book. As an example—a very elementary one—the usual formula $v=\sqrt{2gH}$ for the velocity of flow through an orifice is given, and two proofs are offered without any reference whatever to the

assumptions made. The pressure and direction of motion at the section where the velocity is v is not mentioned, and there seems no escape from the unjustifiable assumption that the velocity v is the velocity through the plane of the orifice; the educational value of a critical study seems to be entirely lost. As another example of the author's unjustifiable assumptions likely to be harmful to students, reference might be made to p. 304, on which is given the usual analysis of the formula of Poiseuille to determine the coefficient of viscosity. It then follows that

$$\frac{mig}{v^2} = 8\left(\frac{dv}{\nu}\right)^{-1}$$

where m is the hydraulic mean depth of a tube and the other terms have their usual significance. Without further discussion he says, "this may be written":

$$\frac{mig}{v^2} = C\left(\frac{dv}{\nu}\right)^{n}$$

"where C and n are constants depending on whether the flow is stream line or turbulent." Such reasoning is entirely unjustifiable, as only by experiment is it, or can it be, known that

$$\int\left(\frac{vd}{\nu}\right) = \left(\frac{vd}{\nu}\right)^{n}$$

when the flow is turbulent.

So far as it goes the text is clear, and typical examples are worked out, but neither in order or treatment can it be said that the author adds to existing works on the subject. Following other writers, he includes a chapter on presses, cranes, etc. Unless a student knows already something of the constructional details of a single-power jigger, it is doubtful if he will gain much from the illustration on p. 342.

(4) The fourth volume, "Modern Waterworks Practice," deals very briefly with the fundamental subject matter of the second and third volumes. It naturally commences with "sources of supply." Reference is made to streams, lakes, and underground supplies, and the necessity for careful investigations before deciding upon the water available. The vexed question of compensating water is only briefly mentioned. Earthen, masonry, and reinforced concrete dams are briefly dealt with. The analysis for the buttressed dam may be right or wrong; from the reading of the text it is impossible to say, and the formulæ given must be taken on trust. The author states that the coefficient of discharge for a syphon spillway is from 0·60 to 0·65, but he gives no authority, and the statement must be taken with great reserve. The descriptions of the various types of plant found in connexion with modern waterworks are clear, though somewhat sketchy, and as a preliminary book for young engineers and students it will be valuable, but for purposes of design, other larger and more critical specialised books will need to be consulted.

A Geography of the World.

(1) *Géographie universelle.* Publiée sous la direction de P. Vidal de la Blache et L. Gallois. Tome 1: *Les Îles Britanniques.* Par Prof. A. Demangeon. Pp. viii + 320 + 56 planches. 80 francs. (2) Tome 2: *Belgique, Pays-Bas, Luxembourg.* Par Prof. A. Demangeon. Pp. iii + 250 + 40 planches. 60 francs. (Paris: Armand Colin, 1927.)

THIS work, of which the first two volumes have now been published, was planned some fifteen years ago, and was already in active preparation when the European War intervened. When work on it was resumed, the originator and editor, M. Vidal de la Blache, had died, but the project was carried through by M. L. Gallois on the lines that had been laid down. The facts of geography are not new, but the geographer can view them at a fresh angle; and this book is an excellent example of how the geographical outlook, with its selection and correlation of facts and linking of cause and effect, can illuminate the description of a country.

(1) Prof. A. Demangeon, in his volume on the British Isles, has given the best account of the geography of this country that has yet appeared. It is not so full as some regional monographs, but it gains in being more vivid, and the picture of the whole is never dimmed by tedious detail. Not only is he comprehensive in his treatment and accurate in his facts, but also he writes with a clear understanding of the attributes and distinctions of the various parts of the country. We can recall nothing in English that is equally successful in portraying and explaining the scenery of Britain and the life of its people.

A book so packed with facts and venturing frequently on estimates of human and social characteristics might well lend itself to easy criticism. But the reverse is true. There is little that one who knows intimately most parts of the British Isles can find fault with. Prof. Demangeon's command of facts is equalled only by his balanced judgment. Some of his chapters on the landscape and its origin also show great descriptive power. We would commend particularly the chapters on

Scotland, with their intimate study of Edinburgh's traits and his long chapter on London, its origin, growth, and life.

One of the few omissions of any significance is an apparent neglect of the port of Immingham, perhaps because its statistics are generally combined with those of Grimsby. Dundee has now no whalers left, and Leith is the only whaling port in Britain. Mention might be made of the part that the granite industry played in the fortunes of Aberdeen. Bibliographies are attached to each chapter. On the whole, they are good, even if a few entries might be replaced by more modern books and a few somewhat trivial books omitted. There is a full index of place names. The illustrations are well chosen and are of real value.

(2) The second volume, on Belgium and Holland, maintains the same high standard and is particularly interesting in its account of the struggle against the encroachment of the sea and the scheme now in progress for the partial reclamation of the Zuider Zee. The complete work in fifteen volumes is to cover the whole world.

R. N. R. B.

Agricultural Education and Research.

Ministry of Agriculture and Fisheries: Intelligence Department. Report on the Work of the Intelligence Department of the Ministry for the Two Years 1924–26. Pp. 86. (London: H.M. Stationery Office, 1927.) 2*s.* 6*d.* net.

IMMEDIATELY after the War there was manifested a great enthusiasm for research in nearly all the branches of science, and in agriculture, where the relation of pure science to the applied branches and to the practice of the field is a very close one, there was launched a number of comprehensive schemes both for the pursuit of knowledge and for its dissemination throughout the agricultural community. The time has now arrived when it is possible to view the good first fruits of some of these schemes and to say *au revoir* to others which have been found impracticable, or were born before their time.

It is eminently satisfactory to find that so much of the original planning has survived the stringent test of action and that the foundations and footings of a great and progressive agricultural service have been established. This service owes a very great deal to the ability and breadth of view of one man, and as it grows and produces its results, not only in Great Britain but also throughout the British Empire, the great work of Sir Daniel Hall will be made manifest. As chief scientific adviser to the Ministry of Agriculture it has been his business to select from the inchoate mass of suggestions, inferences, and wild-cat schemes and to build up a working plan which would cover the needs of fundamental research, agricultural education, and advisory work among farmers, and the terms of the report of the Intelligence Department of the Ministry of Agriculture before us make clear a measure of his success.

Such work and such organisation have required the expenditure of very large sums of money, by far the greater part of which has come from the public purse, but, to take a single year as an example, it is reassuring to find that the £700,000 spent in 1925 on agricultural education and research is equivalent only to 0·3 per cent. of the annual production of the land of England and Wales.

The research institutes, each with its own department of interest, make possible the carrying through of necessary fundamental work in the increase of knowledge and at the same time give the necessary agricultural bias to the scientific facts evolved. Ideally, they should pursue pure science, with a lively consciousness of the agricultural background which must colour their work in the public view. Actually, they vary very much in their regard for pure and applied science and in their appreciation of the fundamental and *ad hoc* problems presented to them.

One of the great difficulties which has been encountered in the past few years has been the supply of men with two sides to their heads, and capable of appreciating at once both the scientific problems presented in pure research and the bearing which these must have upon practical agriculture. This difficulty has been greater, perhaps, in the recruitment of the advisory services than in the research institutes, but it has been encountered in both spheres, and it has often made difficult the maintenance of understanding and sympathy as between laboratory and field workers.

The universities so far have not been entirely successful in producing a supply of research workers who, in addition to possessing a wide view of their subject, are able to think in terms of action. The tendency to strict specialisation in research work is necessarily very great, but there would surely be a great advantage to the agricultural service in general if the young men coming from the universities were compelled to obtain actual field training in some department of an ordinary farm before being allowed to settle down into their allotted groove of work.

Students from Scotland and the north of England have a considerable advantage over the southerners, in that a very large number of them have had to work on the land in their early days, and this may perhaps account for the very large percentage of northerners in the research and advisory services. The provision of scholarships, rich enough to attract really able young men of all classes, and the construction of a sort of ladder by which a bright boy can climb from the village school to the greatest of our universities, via such places as farm institutes and agricultural colleges, has helped the supply of men, but there is still much to be done.

One of the greatest difficulties encountered in the agriculture of the past has been that of the exchange of ideas between experienced agriculturists and the dissemination of trustworthy information. It is almost proverbial that the link between the laboratory and the farmer is a very weak one, and it is therefore all the more satisfactory to find that the agricultural advisory service continues to grow both in numbers and in the good graces of the farmers themselves.

The change in this department in the past twenty years is very remarkable. In 1907 there were scarcely any county organisers and only a few lecturers, and they were regarded with the utmost suspicion by the farmers of their districts. A few outstanding characters earned for themselves reputations for wisdom and soundness, but it was done by force of personality rather than learning. To quote a well-known agricultural adviser addressing a meeting of his colleagues recently: "Twenty years ago no self-respecting farmer would be seen speaking to an organiser; while now they seek you out in the market and, what is more, do what you tell them." There has been a great change of heart, and the present generation of farmers is anxious to learn, and is not convinced that the law of the grandfathers is immutable.

The organisation of the framework of the advisory system is almost complete over the country, and the supply of trustworthy information to farmers on almost every subject connected with their business is assured. It remains now for the advisers themselves and the farmers to take full advantage of the inquiring spirit of the age and of the opportunity which is offered. We, especially those of us who are farmers, have been apt to regard our own coasts as the limit of our concern and interest. This parochial view is shaken daily by the closer contacts in the market and in conclave with other parts of the British Empire, and it is interesting to find that our home advisory service is being depleted of some of its best young men by the creation of attractive posts for them overseas. An Empire Marketing Board, an Imperial Research Conference, a common pool of research workers and advisers—it seems that agricultural science progressive and well organised is about to take its proper place as one of the dominating influences in the development and progress of the Empire.

CLEMENT HEIGHAM.

Our Bookshelf.

Histoire des bois et forêts de Belgique: Des origines à la fin du régime autrichien. Par le Comte Goblet d'Alviella. Tome 1. Pp. xvi + 490 + 18 planches. Tome 2. Pp. xii + 350 + 16 planches. Tome 3. Pp. ii + 140. (Paris: Paul Lechevalier; Bruxelles: Maurice Lamertin, 1927.) 3 vols., 100 francs.

A COMPLETE history of the forests of Belgium from the earliest times up to the end of the eighteenth century is given in these three volumes, which embody the results of much learned research. The economic and social importance of the forests throughout the ages is the main subject of the work, but much light is also thrown on the natural history of the woodlands and on the gradual but late development of scientific sylviculture and forest management. Folk-lore, legislation, charters, archives, ancient MSS., classical writings, and modern books have all been laid under contribution. An agreeable feature of the work is the high quality of the full-page illustrations, which reproduce famous landscape pictures, maps, plans, and photographs.

A great variety of information is scattered throughout the work. In every period much destruction of the original forests has taken place. The early natives and their Roman masters regarded the forests as inexhaustible, and ruthlessly plundered them for fuel and timber. Increasing population necessitated more agriculture for its support, and this was only to be obtained by encroachment on the land covered with trees. From the sixth century onwards, the civilising Benedictine monks, in their zeal for farming, were probably more destructive of woodland than the early pagans. The forests that now exist in Belgium and France owe their preservation throughout the Middle Ages to the feudal lords, who loved the chase, and instituted severe game laws, depriving the peasants of their rights to fell timber and pasture their flocks in the forests. The sites of the ruined forests can often be recognised in the modern names of villages and communes. Ypres was so called on account of the elms (*yppen* in Flemish) which were numerous in the woodland where the town was first built. In the years before the War, the country around Ypres was still noted for its numerous fine elms, which were survivors and descendants of the trees in the original virgin forest.

Lectures on Dielectric Theory and Insulation. By Dr. J. B. Whitehead. Pp. vii + 154. (London: McGraw-Hill Publishing Co., Ltd.; New York: McGraw-Hill Book Co., Inc., 1927.) 12*s.* 6*d.* net.

PROF. J. B. WHITEHEAD, who is professor of electrical engineering at the Johns Hopkins University, has done much valuable research on insulating materials. During 1926–27, when he was an exchange professor in France, he gave a series of lectures on the properties of dielectrics and the phenomena which occur when high electric stress is applied to insulating materials. These lectures he now publishes in book form, and they will be very helpful to physicists and particularly to electrical engineers.

In the first lecture, Prof. Whitehead gives a brief and accurate account of the more important postulates which have been made in the classical theory of perfect dielectrics. Most of the material in the following seven lectures is taken from recent papers on physics and electrical engineering. The results, however, have been co-ordinated and they are presented in a way which will be appreciated by those engaged in research. The author points out the most promising directions for further research. The last chapter is devoted to researches on the properties of composite insulating materials when subjected to very high electric stresses. In this chapter he incorporates many of his own researches on these materials when subjected to high alternating stresses. In conclusion, a very complete bibliography of the subject has been given. It is arranged under six general headings, and we have found it useful.

Bacterial Vaccines and their Position in Therapeutics. By Prof. Leonard S. Dudgeon. (Modern Medical Monographs, edited by Prof. Hugh Maclean.) Pp. vii + 87. (London: Constable and Co., Ltd., 1927.) 7*s.* 6*d.* net.

THIS book is essentially a record of the personal opinions of the author after an extensive experience of twenty years on the preparation and use of prophylactic and therapeutic vaccines in different diseases. Rabies and vaccinia are included, although not strictly bacterial, but prophylaxis by means of diphtheria toxin, and Dick's scarlatina toxin, are omitted. Very few diseases are included for which the author has not himself used vaccines. Much sound and valuable advice is given about the kind of case in which vaccines should be avoided or only given with great caution. For the rest, the advice, if rather conventional and based on almost purely empirical clinical grounds, is backed by experience and free from the uncritical and dangerous optimism of many treatises on the subject. Prof. Dudgeon is adverse to the treatment of acute general infections by vaccines. The more recent advances in the theory of prophylactic vaccines and bacterial antigens are unnoticed, and in this the author consistently adheres to his policy of dealing only with what he himself has tried for a long period. No reasons are given in support of the use of therapeutic vaccines beyond the author's personal belief in their efficacy, and no new experimental evidence is adduced.

Hippokrates: eine Auslese seiner Gedanken über den gesunden und kranken Menschen und über die Heilkunst. Sinngemäss verdeutscht und gemeinverständlich erläutert von Dr. Arnold Sack. Pp. vi + 87. (Berlin: Julius Springer, 1927.) 3·60 gold marks.

IN this booklet, Dr. Arnold Sack, of Heidelberg, has made a judicious selection of the most important passages in the works of Hippocrates and rendered them into readable German. The passages selected include the oath, and extracts among others from the law, the surgery, the epidemics, airs, waters, and places, the prognostics, dentition of infants, nature of man, care of health, and numerous aphorisms.

In the postscript, Dr. Sack maintains that though nothing definite is known about the life of Hippocrates, it is certain that he was not a mythical personage, but really did exist, as is shown by allusions to him in Plato's dialogues, and not only practised medicine but also wrote medical works. It was not until many centuries after his time that commentators of the Hippocratic works appeared in Alexandria, Athens, and Rome, the most prominent of whom were Galen and Herophilus. No critic has yet been able to determine with certainty which of these works was written by Hippocrates himself and which by his pupils. It is, therefore, not surprising that some of the passages selected by Dr. Sack are from works regarded by other commentators as spurious.

Finlayson's Clinical Manual for the Study of Medical Cases. The fourth edition. Edited by Dr. Carl H. Browning, Dr. E. P. Cathcart, and Dr. Leonard Findlay; revised and augmented throughout by various contributors. Pp. xvi + 815 + 4 plates. (London: G. Bell and Sons, Ltd., 1926.) 18*s.* net.

MANY physicians and students will greet with pleasure the publication, after an interval of thirty-five years, of a new edition of "Finlayson's Clinical Manual." The great progress made in all branches of medicine, and particularly in diagnostic methods, has necessitated the complete revision of some parts of the book and the inclusion of much that is entirely new, but the general plan of the original has been retained, and there has been no departure from the principles of medical training indicated by the late Dr. Finlayson. The student is still taught the prime importance of observation at the bedside, first and mainly with his eyes, next with the hands, and last and least with the ears. Laboratory methods, however, are not neglected. The technique of reactions which come only within the sphere of the bio-chemist is naturally omitted, but full details are given concerning investigations of general value, including recently evolved tests such as that of van den Bergh. The manual contains useful tables and a very complete index, and there is no doubt that this edition will be as popular as were its predecessors.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The 'Palæolithic Implements' from Sligo.

WE have read the reply of Messrs. Reid Moir and Burchell, published in NATURE of Nov. 26, to our letter on the above subject. We note that we or our observations are old-fashioned, unwise, faulty, mistaken, abortive, dogmatic, and so forth; but we find little or no serious attempt to meet the main points of our criticisms, and we are so "unscientific" as to hold that detraction is not argument.

Messrs. Reid Moir and Burchell specified three sites as sources of their 'implements.' They admit by implication that we identified two of these; for they make no effort to question any of our statements regarding them. The third, they suggest, we "failed to observe." This is not the case; and their suggestion, based as it is upon an ambiguity of topographical nomenclature, is scarcely ingenuous. The square-headed promontory of carboniferous limestone, south of Drumcliff Bay, comprises the townlands of Upper and Lower Rosses. In some of the older maps only the north-western angle of the promontory is called Rosses Point: but in current modern usage this name has been extended far beyond that narrow application, to which Messrs. Reid Moir and Burchell now wish to confine it. The village, church, post-office, hotels, etc., of Rosses Point all lie along the *south* coast of the promontory, one to two miles distant from the north-western angle. Those unacquainted with the district can verify this by reference to any recent map, such as the six- or one-inch Ordnance, Bartholomew's quarter-inch, the Admiralty Chart, etc. Knowing this, and assuming that Mr. Burchell also knew it—as we think he must have done—we covered with our survey the "western or seaward side" of the whole promontory, *including* the north-western angle; with the results stated in our first letter. We have there already mentioned the only features, along the strip of coast in question, to which the term 'rock-shelter,' fallen-in or not, could by any stretch of imagination be applied; or to which Mr. Burchell's ambiguous indications could in reason be referred.

At this north-western angle, where we now learn definitely that Mr. Burchell's 'rock-shelter' is situated, we found only an ordinary storm-beach, composed of angular blocks derived from the rocks around it; and limited, as to its dimensions, by the nature of the ground, the character of the rocks, and the manner of their erosion. As there can now be no doubt that this is what Mr. Burchell claims to be a fallen-in rock-shelter, it becomes necessary to describe it with some particularity.

The beds of limestone referred to dip at a low angle towards the north-west. At the spot where the 'rock-shelter' is situated three beds are present. The *upper*, evidently the 'roof' of the 'rock-shelter,' is formed of a very cherty, much jointed grey limestone, and is about 2 feet thick. The *middle*, which is about 4 feet thick, consists of more thinly bedded grey limestone, almost devoid of chert. The *lower*, the 'floor' of the 'shelter,' is a more massive and compact limestone, brownish on the surface, quite devoid of chert, and easily distinguished from the other two.

The middle bed yields to marine erosion a little more rapidly than either of the others. In consequence, undercutting of the upper bed is continually in progress; but, owing to its strong jointing, blocks fall away from it before there is any marked overhang. For this reason it is impossible that it could ever have formed a roof capable of giving shelter. The erosion of the middle bed exposes the lower bed, and from this latter rather large blocks, sometimes as much as three or four feet in length, become detached from time to time, and are cast up to a higher level by the winter waves. The erosion of the three beds thus advances, to all intents and purposes, concurrently.

The resulting storm-beach covers the whole area of the alleged 'rock-shelter'; and its dimensions agree with those of the 'shelter,' as given by Mr. Burchell. But of the blocks which compose it, only about one-third come from the cherty upper bed (the 'roof'): the other two-thirds come mainly from the lower bed (the 'floor'), having been cast up by the waves to a height several feet above their original position, so that they overlie some of the smaller debris.

The middle bed breaks up more readily into small pieces, with angular fractures. Many of these fragments are so recently broken that they have not yet been rolled by the waves, though some of them display chipped edges, produced by marine action. Storm-waves have free access to this material, as is shown by the copious admixture of recent marine shells associated with it—some of the bivalves being so fresh that they still retain their ligament. This mixture of stones and shells lies around and beneath the larger blocks; and it is from this material that Mr. Burchell's 'implements' have been selected.

The suggestion that this mass of rock debris could have formed the roof and contents of a Palæolithic rock-shelter would have appeared to us so ludicrous, had it so much as occurred to us, that we should have dismissed it forthwith. Since the publication of Messrs. Moir and Burchell's most recent letter, definitely indicating this spot as the site of their rock-shelter, two of us have revisited the place and re-examined it with care. Their report confirms us in our former conclusion—that it presents nothing more than a typical storm-beach, similar to those that are to be seen on Coney Island and at other places in the neighbourhood.

After this second, more thorough examination, we are now able to say that in spite of Mr. Burchell's depredations it would still be possible to select, from among these fragments, specimens presenting a very passable resemblance to implements. There would be no difficulty also in finding among them shapeless lumps of stone which the most sanguine could never mistake for artificial products. If these two groups were laid out at a short distance apart, we might, with no very great expenditure of time and trouble, fill in the space between them with a complete seriation of forms, gradually approximating from the one to the other. Even without the advantage of seeing Mr. Burchell's carefully chosen specimens, we can well believe that they look very convincing on the table of the Society of Antiquaries: but we suspect that they would be less impressive if they were lying where the last storms left them, mingled with these countless intermediate forms and with modern sea-shells.

Mr. Burchell's "Raised Beach of powdered shells" can be readily seen in the earthy bank just behind his 'rock-shelter,' though his reason for calling it 'Early Neolithic' is less obvious. It is a mere upward extension of the recent beach, and is likewise due to storm action, probably within the last century or two. The lighter fragments have been

projected by spray and wind farther than the heavier ones—that is the only difference which this upper edge of the beach presents in contrast to the lower part. The shells are of species now common in the bay, including *Solen siliqua* (predominating), *Venus gallina*, *Cardium edule*, *Donax vittatus*, *Mytilus edulis*, *Ostrea edulis*; they occur in the same relative proportion from the highest point of the so-called 'raised beach' down to the lowest point of the present beach.

By quoting in support of their case a reference from the Geological Survey Memoir to a raised beach at Carney, Messrs. Moir and Burchell show themselves to be unaware that the study of Irish raised beaches has progressed within the forty years which have elapsed since that memoir was published. The Carney 'raised beach' is wrongly so described; it consists of shelly deposits, due either to recent storm action or to human agency. Similar shelly beds are frequent along the Irish west coast, as in Counties Mayo, Galway, and Clare. Those of human origin date, some from the famine year (1847), some earlier, some later. The well-known 25-ft. beach of Northern Ireland, so conspicuous in the north-east, drops to sea-level and merges with the present beach in Co. Wicklow in the east, and Co. Sligo in the west, as is well shown in Wright's "Quaternary Ice Age," p. 422, Fig. 151. We repeat: No raised beach is known within this area.

If they had realised it, we were doing Messrs. Moir and Burchell a service in pointing out their error in this matter. For, under the conditions prevailing on this spot, a Neolithic raised beach overlying a Palæolithic rock-shelter, such as Mr. Burchell describes, would be damning evidence against his claims. We invite a consideration of what it would involve. (1) A rock-shelter formed by marine action in strongly jointed and bedded limestone, on very exposed ground, with (2) Mousterian implements on its floor; (3) heavy glacial erosion of the district; (4) submergence, until a beach was deposited above its roof; (5) emergence, until its floor was a few feet above ordinary high-water mark; (6) recent coastal erosion, postulating more rapid erosion during the two preceding phases; and (7) after all these vicissitudes, the rock-shelter still surviving, save for blocks fallen from the roof, and still retaining exposed on its floor "more than 100 *unrolled* flakes and flake implements made of limestone"! (The italics are ours.)

Messrs. Reid Moir and Burchell complain that we prejudged the authenticity of the material removed to London without having examined it. If they will refer to our previous letter they will see that we were careful to avoid doing this. They also charge us with a desire to maintain at all costs a preconceived theory of the absence of Palæolithic remains from Ireland. Personalities of this kind possess neither interest nor importance, and are best ignored: but we may permit ourselves to say that here also they make a statement contrary to fact. We are ready to welcome any discovery of Palæolithic man in Ireland, by whomsoever made. We visited Rosses Point with perfectly open minds. Had we found that the sites agreed with Mr. Burchell's description, we should naturally have endeavoured to follow up our inspection of the ground with an examination of his collection. But the geological evidence proved so destructive that we considered that no useful purpose would be served by a journey to London, until the difficulties presented by the nature of the sites had been cleared up. This, we repeat, Messrs. Moir and Burchell have made no serious effort to do: accordingly our case rests where it did.

Much more might be said on other points that have been raised in this correspondence: but we do not propose to trespass further on the hospitable columns of NATURE, unless some new statement of fact be made, which in our opinion calls for notice. Just as a sentence removed from its context can convey a surprisingly false impression, so the Sligo 'palæoliths,' brought to notice by Messrs. Reid Moir and Burchell, cannot be fairly and fully judged without a competent study of the sites that yielded them.

R. A. S. MACALISTER.
J. KAYE CHARLESWORTH.
R. LLOYD PRAEGER.
A. W. STELFOX.

Dublin, Dec. 5.

Thermodynamics, Wave-theory, and the Compton Effect.

PROF. A. H. COMPTON'S own explanation of the remarkable phenomenon discovered by him is well known and is set out very clearly in his recent book on "X-rays and Electrons." Briefly, it is that radiation is of a corpuscular nature, that the momentum of the impinging quantum detaches the electron from the atom and causes it to recoil, while the deviated quantum loses energy in the process and degrades in frequency. This view of the Compton effect, like Einstein's explanation of the emission of photo-electrons, approaches the relations between matter and radiation from a point of view so divergent from that of the familiar concepts of Maxwellian electrodynamics, that it is scarcely possible to understand how this conception of radiation is physically reconcilable with the familiar explanations of interference and diffraction phenomena.

As is well known, there is an addition to the X-ray scattering of degraded frequency, an unmodified secondary radiation the existence of which has been explained by Prof. Compton as due to the whole group of electrons in the atom scattering conjointly. To this view, the objection might be raised that if one electron acting alone can scatter a quantum, and also all the Z electrons in the atom acting together, then why do we not observe scattering by two, three, or more electrons acting together at a time, with their corresponding fractional Compton shifts in wave-length? To the alternative explanation of the unmodified scattering given by Profs. Compton and Jauncey that it represents the scattering by an electron which the impinging quantum is unable to detach from the atom, the equally pertinent query may be asked, then why is the intensity of this type of radiation proportional to Z^2 and not to Z?

In addition to these objections to Prof. Compton's explanations of his own discovery, there is another of a very fundamental nature which was also urged by me when, by invitation, I spoke at the British Association meeting at Toronto in August 1924, on the problems of the scattering of radiation. Maxwell's theory of light not only explains the classical phenomena of interference and diffraction, but also, when taken in conjunction with the principles of thermodynamics, affords a very complete explanation of the phenomena of the scattering of ordinary light in gases, liquids, and crystals under the widest range of physical conditions. This has been fully demonstrated by me and my associates in a series of experimental and theoretical researches during the last six years. Is it conceivable, then, that Maxwell's theory and thermodynamics taken together would fail in the closely allied field of X-ray research? Urging this point of view, I referred at the Toronto meeting to the beautifully simple explanation which

the classical wave-theory and thermodynamics together give of the X-ray diffraction haloes in liquids.

During the current year I have returned to this subject, and in a series of memoirs which are being published in the *Indian Journal of Physics*, have developed a general theory of X-ray diffraction and scattering in which thermodynamics, the classical wave-principles and modern views of atomic structure are brought together and shown to afford a simple and intelligible explanation, not only of Prof. Compton's own discovery, but also of the crucial experiments of Bothe and Geiger, and of Compton and Simon, which at first sight seem so destructive of the classical wave-ideas. It is not possible in the columns of NATURE to afford more than the briefest indication of the line of thought followed in these memoirs.

The facts of temperature radiation from solids and fluids compel us to assume that the thermal agitation of bodies excites not only the atoms but also the electrons contained in them. Starting from this premise, it is shown on Maxwellian wave-principles that we must have two types of secondary X-radiation, one of intensity proportional to Z^2 which corresponds to the normal or stationary state of the atom, and the other proportional to Z produced by the thermal fluctuations of the internal structure of the atom. The former is a stationary or diffraction effect, and the latter is of a highly fluctuating type, the intensity of which has no fixed values at any time or place and the laws of which can only be formulated as statistical relationships. This type of scattering is identifiable with the Compton effect, and the observed variations of the latter with direction of observation, atomic weight of scattering atoms and wave-length of X-rays, and the observed fluctuations with respect to time and direction, are all satisfactorily explained.

In addition to these, the theory indicates that as the Compton effect is essentially a thermodynamic phenomenon involving degradation of energy, it should show a marked dependence on temperature. Experiments to verify this are in progress at Calcutta, but there are already sufficient indications in the literature of X-ray scattering and absorption and their variations with temperature to indicate that the success of the experiments is a foregone conclusion. The results of the experimental work will also be published in the *Indian Journal of Physics*.

C. V. RAMAN.

210 Bowbazar Street,
Calcutta, Nov. 10.

The Magnetic Properties of Single Crystals of Nickel.

LAST year Dr. Honda and the present writers published a paper dealing with the magnetic properties of single crystals of iron (NATURE, **117**, 753; 1926). The present paper contains the result of the similar investigations on nickel. In order to obtain large crystals of nickel, a strained bar of electrolytic nickel melted *in vacuo* was continuously heated at 1300° C. for several days, but the result was the formation of twinning crystals of several millimetres in length and no further growth took place. In the second trial, molten metal was cooled from the bottom of the crucible containing it by slowly lowering the vessel out of an electric furnace; in this way we were able to prepare large crystals of nickel, 7 cm. in length and 2·3 cm. in diameter.

From these crystals three oblate ellipsoids, the flat planes of which coincided respectively with three principal planes (100), (110), and (111), were prepared. The major axes of the ellipsoids were about 20 mm. and the minor axes 0·6 mm. The processes of sawing and filing were always done by hand very carefully so as to avoid the least distortion of the crystal.

The results of the measurement of the magnetisation in the direction of the principal axes of the crystal are shown in Fig. 1. As is seen in the figure, the magnetisation curves in the directions of the tetragonal, digonal, and trigonal axes are almost straight, and coincide with each other up to an intensity of magnetisation of 205. Above this intensity the magnetisation varies for the different axes of the crystal, the trigonal, digonal, and tetragonal axes showing a decreasing order of magnetisability. This is just the reverse of the case of iron crystal. The saturation intensity of magnetisation is 503, which is

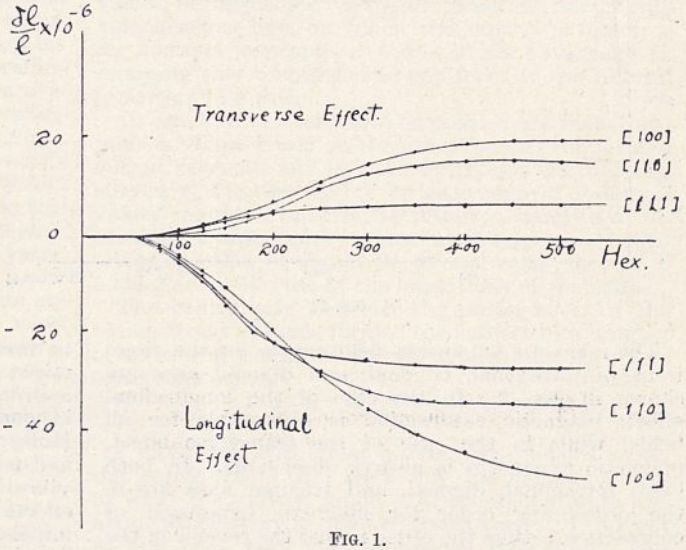

FIG. 1.

higher by 5 per cent. than the value 478 obtained by P. Weiss, and lower by 1 per cent. than the value 509 determined by E. Gumlich.

In plane (100), both parallel and perpendicular components of magnetisation in a constant field vary with a period of 90°. For the parallel component, the direction of the digonal axis has the maximum magnetisation, and that of the tetragonal axis the minimum magnetisation; but for the perpendicular component, the magnetisation vanishes in the direction of the tetragonal and digonal axes and attains a maximum or minimum between them. When the intensity of the magnetic field increases, the amplitude of these periodic changes increases, attains a maximum, and afterwards gradually decreases. The above periodic change coincides qualitatively with the case of iron crystal, when the direction of its principal axis is supposed to be rotated by 45°; this difference may be expected from that of the lattices in (100) plane for iron and nickel crystals.

In plane (110), two components of magnetisation vary with a period of 180°. For the parallel component, the principal and secondary minima take place respectively in the directions of the tetragonal and digonal axes, and the maximum in the direction of the trigonal axis.

In plane (111), the two components of magnetisation

vary with a period of 60°. The amplitude of these periodic changes is very small, not exceeding 4, which is only 4 per cent. of the maximum amplitude in the plane (110). In a weak field, the parallel component of magnetisation in the direction of the side of the equilateral triangle forming the space-lattice is a minimum, and that in the direction of the bisectors of the vertical angle of the triangle is a maximum; but in a stronger field the opposite is the case. These relations coincide qualitatively with the case of the (111) plane in the iron crystal when the direction of the principal axis is rotated through 30°.

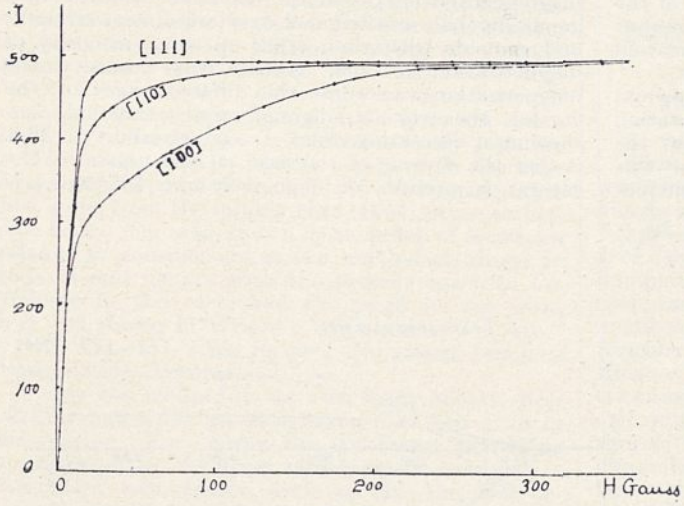

FIG. 2.

The magnetic expansion–field curves for the directions of tetragonal, trigonal, and digonal axes are shown in Fig. 2. In the case of the longitudinal effect, magnetic contraction is observable for all fields, while in the case of the transverse effect, magnetic expansion is always observable. In both cases tetragonal, digonal, and trigonal axes are in the descending order for magnetic expansion or contraction; thus the order is just the reverse of the magnetisability.

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New Methods of Electrically Maintaining Mechanical Oscillations.

IN the article on radio-frequency measurements in Glazebrook's "Dictionary of Applied Physics" (vol. 2, p. 635), Dye states that "quite powerful longitudinal vibrations in steel bars can be produced by acting on them with currents of the resonating frequency." From conversation with Dr. Dye, I gather that this refers to some otherwise unpublished work in which the oscillations are maintained by electric, that is, electrostatic, forces derived from an oscillating valve set and a polarising battery.

Experiments made by me on audio-frequency oscillations of metal rods under electric forces from a valve show that these vibrations can be obtained of great intensity with surprising readiness. The metal bar (of cast steel, mild steel, or brass) is clamped at its centre, and one plane end is placed close to the plane surface of a massive block of metal. This block and the bar are connected one to each side of the condenser of the valve maintained circuit, a polarising battery being inserted in one of these leads. Tuning is carried out at first by comparing the note emitted by the bar when struck endwise with that heard in the ear-piece of a reed telephone, to which no leads need be attached, since the stray magnetic field from the induction coil in the valve set makes it give out a note of the frequency of the set. The final tuning may be made in this way by beats, or by beats between the forced oscillations of the bar and its natural oscillations evoked by impact.

A bar of the same material of half the length will vibrate without the polarising battery if the condenser in the maintaining valve set be cut down to a quarter of its former capacity. The fine tuning in this case is by beats between the natural note of the bar and a faint note emitted by the induction coil of the set. This note is due to the unpolarised vibration of the structure of the coil set up by the main oscillating current. Rods and tubes of electrically non-conducting material could doubtless be caused to oscillate in both these ways, that is, by polarised or unpolarised electromagnetic forces, by winding them suitably with conductors. Non-conducting rods could also be used for the electric attraction method after rendering one end conducting and providing a conducting path from this end to the clamp by plating or otherwise. The advantages of fused quartz for such work are patent.

Magneto-striction is a unidirectional effect in nickel. In iron and steel the effect is less, and in some circumstances does not increase with increase in field. There appeared then the possibility that attempts to maintain oscillations by magneto-strictive forces might fail with iron and its varieties, but succeed with nickel. Troubles threatened to arise in consequence of eddy currents and hysteresis. However, it turned out on trial that cast steel bars and mild steel bars could be maintained in resonant vibration with very great facility. With nickel the effects are even more striking. Both polarised and unpolarised electrostrictive forces may be employed. In the polarised case a coil carrying a constant current surrounds the middle of the bar, and the oscillating current from a valve set is sent round a coil conveniently wound on the same former. To obtain the unpolarised effect, care should be taken that the bar is not magnetised to begin with. If it is magnetised one can very readily obtain the polarised effect; the permanent magnetic state of the bar then performs the function of the direct current. If the induction coil of a 'tuned anode' assemblage with grid coil coupling be itself used to provide the alternating field, then it is convenient to provide a separate winding for the direct current. In this case a galvanometer in the grid coil will indicate the presence of the oscillating bar.

The variations in the deflexions of the grid galvanometer are similar to those in which the set is influenced by a neighbouring resonating circuit, a result in accord with the masterly researches of Butterworth (*Proc. Phys. Soc.*, vol. 27, p. 410). On increasing the capacity very slowly, as resonance is approached, the deflexion falls until a value of the capacity is reached marked by a sudden drop in the current; this fall is immediately followed by a sudden rise to less than the previous value. On reversing the changes in capacity the deflexion decreases and then suddenly rises at a value of the capacity differing slightly from that at which the drop occurred as the capacity was increased. The exact point of resonance lies

between these two values. This method of tuning a valve set to the resonant frequency of a neighbouring circuit is a modification of Austin's well-known 'double click' method. Both methods are described in Moullin's "Radio Frequency Measurements," pp. 14 and 136. In an experiment on a nickel rod a metre long and 2·54 cm. diameter, the critical points on the condenser scale were separated by an interval of a four thousandth part of the whole capacity. On clamping the bar by means of heavy lead weights these irregularities disappear. Clamping the bar corresponds to breaking the connexions in the neighbouring circuit.

Such experiments need not be confined to bars of one material; nickel or iron could be suitably attached to bars of other materials. Nor need the oscillations be wholly longitudinal; for example, a conventionally shaped tuning fork could be thrown into resonant vibration by subjecting the junction of the prongs to a vibrating magnetic field in the plane of the fork and at right angles to the prongs.

The field producing magneto-striction may be due to a current carried by the magneto-strictive body. Thus when a current traverses a wire of nickel its circumference shrinks and the whole wire will therefore tend to increase in length. Thus Beatson heard a sound produced by an intermittent current flowing in an iron or steel wire (Beatson, *Elect. Mag.*, April 1846). This reference is taken from a remarkably interesting paper by Honda and Shimizu (*Phil. Mag.*, vol. 4, Series Six, p. 645) entitled "Note on the Vibration of Ferromagnetic Wires placed in a Varying Magnetizing Field," and published twenty-five years ago. In their paper the earlier work is reviewed and an account is also given of their own experiments on the subject carried out with such resources as were then available for experimenters. Magneto-strictive oscillations are so readily produced that it may well transpire that materials which when tested by static methods do not exhibit the effect will, when subjected to properly tuned fields, be found to possess it. For example, some variety of invar may be sufficiently magneto-strictive to oscillate in a tuned field; so that in addition to obvious important technical applications such as the provision of sources of oscillations and frequency standards, this method may be of scientific value.

A paper on some parts of this very wide and fascinating subject is in preparation.

J. H. VINCENT.

L.C.C. Technical Institute,
Paddington, London, Nov. 30.

Standardisation of Telephone Apparatus.

IN the article on my paper on telephone apparatus standardisation in NATURE of Nov. 26, the writer states that it is not easy to understand what telephone engineers mean by a transmission unit, and I agree that if reference only is made to the short statement included in my paper this is certainly true. I may, perhaps, therefore be allowed to supplement this statement by the following remarks:

Until recently the telephone engineer expressed losses and gains in transmission efficiency in two ways, namely: (1) in terms of the product of attenuation constant and length, βl; (2) in terms of a standard cable having certain definite line constants.

The objection to (1) is that it is strictly applicable only to a homogeneous telephone line of infinite length, and that such lines do not occur in telephone practice, and that, furthermore, the product of attenuation and length is meaningless when applied to a piece of telephone apparatus.

The objection to (2) is that it is arbitrary, and is dependent on the frequency transmitted.

βl, however, is equivalent to $\log_e \frac{i_1}{i_2}$ or $\log_e \frac{v_1}{v_2}$ or $\frac{1}{2} \log_e \frac{p_1}{p_2}$, where i_1, i_2, v_1, v_2 and p_1, p_2 are input and output currents, voltages, or powers respectively.

In this form the conception of a product of attenuation and length has disappeared, and hence the application to non-homogeneous and short lines and to apparatus generally is logical. So far this is the argument for the use of the unit termed the 'néper,' which is equivalent to $\frac{1}{2} \log_e \frac{p_1}{p_2} = 1$.

The advocates of the unit termed the 'bel,' that is, $\log_{10} \frac{p_1}{p_2} = 1$, claim that in this form the relationship between the numerical values of the units and the actual input and output power ratios is much simpler to memorise and more convenient for use by working telephone engineers than when natural logarithmic values of ratios are used, and that as the infinite homogeneous line, on which the unit βl is based, is an abstract conception, there is no advantage in retaining this conception in the form of the natural logarithm of a ratio.

In conclusion, it may also be pointed out that transmission values based on the direct ratios of input and output powers could be used to express transmission efficiency, if it were not for the large range of numerical values required, and the fact that a number of individual transmission values would require multiplying together to obtain the overall value, instead of adding as in the case of the logarithms of the ratios.

The controversy between the protagonists of the two different systems formed the subject of a number of articles appearing in the *Electrician* and elsewhere some time ago.

B. S. COHEN.

I HAVE read with great interest Mr. Cohen's letter, but regret that I still have only the haziest notions of what the various kinds of transmission units are, about which there is so much controversy. I thought at first they were the 'telephone traffic units,' but as these depend on the calls in a specified period of time (see B.E.S.A. glossary No. 9932) it could not refer to them. Mathematical engineers like Dr. Fleming call β the wave-length constant and α the attenuation constant. Apparently a distortionless circuit is considered. I assume that a 'homogeneous' circuit is the same as what Heaviside called a distortionless circuit. Until clear, mathematical definitions of the 'transmission units' are given, it seems a waste of time to discuss them at international or other meetings.

THE WRITER OF THE ARTICLE.

John W. Draper's Position in Science.

IN NATURE of Sept. 24 the interesting Calendar of Discovery and Invention states that the first astronomical photographs were made in 1840 by John W. Draper, using daguerreotype plates; also that Draper's last great photographic achievement was a record of the nebula in Orion, made on Sept. 30, 1880, and that attempts at improving on this first effort were cut short by Draper's death. Here, at New York University, where Draper was a member of the faculty during the productive years of his life, we were gratified to see this appreciative note about him. In the interest of accuracy, however, it should be stated that the photographs of the great nebula in Orion were

obtained by Draper's son, Henry, who was in his own right the leader of stellar photography in America. The photograph made on Sept. 30, 1880, was given 57 minutes of exposure. In March 1881 a better photograph was made by Henry Draper from an exposure of 104 minutes, and on Mar. 14, 1882 (more than two months after the death of John W. Draper), a remarkably successful exposure of 137 minutes was made, which showed stars of the 14·7 magnitude of Pogson's scale—stars invisible to the eye. Henry Draper also obtained many excellent photographs of the spectrum of the nebula in Orion. Unfortunately, Henry Draper died suddenly on Nov. 20 of the same year at the age of forty-five.

The reference in the Calendar to the first astronomical photograph undoubtedly means the daguerreotype of the moon made by John W. Draper in 1840 after an exposure of 20 minutes—a representation about an inch in diameter. Daguerre had attempted the feat but without success. John W. Draper experimented in photographing the solar diffraction spectrum on paper before the daguerreotype process was invented, but he did not know how to develop and fix his image, until Daguerre, Talbot, and Herschel worked out their developing and fixing processes. Herschel made the first useful photograph of the solar spectrum in 1840; Draper did not succeed in this until 1842.

For some time I have been anxious to learn the true evaluation of John W. Draper's place in science. He was a man of such varied interests and was *au courant* with so many scientific developments that it is difficult to gauge his status. For example, thirteen years before Kirchhoff published his celebrated memoir on the relations between the coefficient of emission and absorption of bodies for light and heat, Draper had arrived at some of these same facts non-mathematically. There is no doubt that Draper contributed importantly to the advancement of knowledge of radiant energy. Just how much credit is due to him for his varied researches is the question.

P. B. McDONALD.

New York University,
Nov. 30.

A Theory of the Upper Atmosphere and Meteors.

THERE seems to be a factor omitted by Mr. Maris in the second paragraph of his letter in NATURE (Dec. 10, p. 839) which may modify somewhat the figures he gives. If the constituents of the atmosphere were uniformly mixed at all altitudes and then left free from convection currents, there would be a partial separation into lighter and heavier particles undoubtedly, but the level reached by the diffusing gases would be conditioned by three factors.

These will be realised readily if we remember that the earth is, in fact, a huge centrifuge and (neglecting convection currents, together with the steady flow into space of some of the lightest particles) the equilibrium position of any constituent depends on (1) gravity, (2) centrifugal force (if I may be pardoned for using such an old-fashioned expression), and (3) osmotic pressure. (2) is small compared to (1), and our centrifuge is therefore one in which the heavier particles converge inwards, but this movement is arrested by (3) just as in an ordinary centrifuge. Unfortunately, so far as I am aware, the osmotic pressure of a mixture of gases has not been determined; I would, however, suggest that if the 'optical centrifuge' described by me (NATURE, Dec. 10, p. 840) were charged with a mixture of argon and hydrogen, some light might be thrown on the subject.

BERKELEY.

Berkeley Castle,
Gloucestershire.

Further Hominid Remains of Lower Quaternary Age from the Chou Kou Tien Deposit.

AT a meeting of the Geological Society of China, held on Dec. 2, 1927, announcement was made of the discovery of a lower molar hominid tooth in the cave deposit at Chou Kou Tien, near Peking. The new specimen was obtained close to the site from which the first hominid teeth from this locality were recovered and in the same stratum of the deposit (NATURE, Nov. 20, 1926, p. 733). This deposit, which at first was thought to be Upper Pliocene, is now known to be basal Lower Quaternary in age (very early Pleistocene). The find was made on Oct. 16 by Dr. Birger Bohlin, palæontologist attached to the Geological Survey of China. Mr. C. Li, geologist from the Survey, and Dr. Bohlin have been in charge of the extensive excavations on this important site, which have been carried on during the past season by the Geological Survey in co-operation with the Department of Anatomy of the Peking Union Medical College.

The tooth is a relatively unworn and perfectly preserved lower permanent molar, having incompletely formed root tips, and evidently from an individual in the stage of development represented by that of an eight year old modern European child. The general morphology of this specimen leaves no room for doubt as to its hominid status, and it evidently was derived from the same jaw as that from which came the lower premolar tooth discovered last year by Dr. O. Zdansky. A full description of the latter specimen and of the associated worn upper molar has been published this year by Dr. Zdansky (*Bull. Geol. Soc. China*, vol. 5, No. 3).

Evidence of a convincing nature points to a close mutual relationship between the two individuals, adult and immature, represented by the teeth recovered from the Chou Kou Tien deposit. The newly discovered specimen displays in the details of its morphology a number of interesting and unique characters, sufficient, it is believed, to justify the proposal of a new hominid genus Sinanthropus, to be represented by this material. A complete and fully illustrated report on this new specimen is now in press, and will be published early in December in Series D, *Palæontologia Sinica*, vol. 7, Fasc. 1.

DAVIDSON BLACK.

Department of Anatomy,
Peking Union Medical College,
Peking, China,
Nov. 24.

The Publications of the Royal Society.

IT would be a pity if—as, of course, cannot be intended—the remarks in the leading article of Dec. 17 were taken, among an uninstructed public, to imply some disparagement of the scientific quality of the output of the Cavendish Laboratory in proportion to its extent. In the present avalanche of theories of atomic processes and radiation, what appears to be necessary more than ever is precise and informed experiment in this complex and elusive domain. Where are we likely to secure these ideals if not in a company where all the practical experience of all the ages of radio-activity is concentrated? At any rate, it may be permitted to record the judgment of one outside student of current physical literature, that it is not there that the fault, if any, is to be located.

JOSEPH LARMOR.

Cambridge,
Dec. 19.

The Antirachitic Vitamin D.

WHILE the chemical nature of the six known vitamins remains obscure, recent advances in knowledge have brought us very much nearer to understanding that of one of them, namely, the antirachitic vitamin D. This has been brought about through the work of Rosenheim, Webster, Drummond, Heilbron, Hess, and Windaus, some of whom have now shown conclusively that vitamin D may be produced in a highly concentrated form from a pure crystalline substance, ergosterol, merely by acting upon it with sunlight or the radiation from a mercury-vapour lamp. This discovery is of great practical as well as scientific importance.

Following the observations that the cure of infantile rickets was brought about by exposure of the body to ultra-violet light and by administration of cod-liver oil, it was found that a number of foodstuffs containing cholesterol, after exposure to ultra-violet light, were rendered effective as curative agents for rickets artificially induced in rats by previously feeding them on a diet devoid of vitamin D. From this the workers referred to were led to study cholesterol, ergosterol, fungisterol, and α-, β- and γ-sitosterols. At first it appeared that each of them developed activity under the influence of ultra-violet irradiation; but later it was shown that these compounds can only be purified with some difficulty, and it was proved that cholesterol and β- and γ-sitosterol when completely purified can no longer be activated by irradiation, and there is reason for supposing that the same will be found to be true of α-sitosterol and fungisterol. On the other hand, all the evidence goes to show that ergosterol is the sole antirachitic precursor.

If this be so, then ergosterol must be present in practically all fats of animal or vegetable origin, for all of these are capable of activation by irradiation, but it is found chiefly in fungi—in ergot of rye and in yeast.

When ergosterol is exposed to ultra-violet irradiation, it loses its crystalline character and becomes resinous. Oxygen does not appear necessary for this change, which can in fact best be effected *in vacuo* or in an atmosphere of nitrogen. The resinous substance thus formed is very highly active in curing rickets. The activity is, however, destroyed if the irradiation be long continued. Irradiated ergosterol has been found to possess remarkably powerful physiological activity; indeed, Miss K. H. Coward has shown that its calcifying effect can be demonstrated with so little as 1/100,000 mgm. administered to a rat in daily doses.

Of the vitamins, vitamin D is the one which pre-eminently needs to be artificially added to the diet, especially in sunless climates. The reason for this will be clear when it is considered that it is chiefly formed in animals rather than in plants, and results from exposure of the animal to sunlight or to a source of ultra-violet rays. It is well known that the sebaceous glands contain sterols and sterol esters, and there is good evidence for believing that it is from this source that the animal derives its antirachitic vitamin. It has been shown, moreover, that the liver acts as a storehouse for this vitamin when produced, and that a reserve is set up in the animal during the summer months, by which it is enabled to maintain good health during the winter. It has been shown, too, that, as a consequence of the impoverishment of the store, the milk of a cow contains progressively less vitamin D as the winter months proceed. Milk and butter provide the most important dietetic sources of this vitamin; and for this reason, and because of the weakness of the sun's rays in winter, human kind suffer then impoverishment in respect of vitamin D, which is neither produced by the action of the sun's rays on their skins nor supplied in their diet in adequate amount.

Vitamin D appears to be necessary to the animal body for the proper control of the calcium balance, and a lack of it results in a depression of the phosphorus or calcium, or of both, in the blood. Moreover, the more cereal there is in the diet, especially oatmeal, the greater is the amount of vitamin D required. Its practical importance is by no means limited to the prevention or cure of rickets, but applies also to other conditions causing greater or less ill-health and suffering. It has, for example, already been shown by the admirable work of Prof. and Mrs. E. Mellanby that dental caries may be traced to a deficiency of vitamin D. From their work it would appear that, in a growing child, bone formation makes a first call on the calcium metabolism and may rob the teeth unless sufficient or an excess of vitamin D is provided. Indeed, dentists throughout England can point to innumerable examples of dental caries traceable to the substitution of margarine for butter during the War. In childbirth the drain on the mother is well known to result in dental caries, and there is strong reason for supposing that this could be prevented by the administration of more vitamin D.

The growth of population is such that the world production of butter is becoming insufficient to provide for all an adequate ration of vitamin D. Cod-liver oil provides another source of vitamin D, but irradiated ergosterol has the great advantage of being practically without taste. Moreover, it is less expensive, and being of standard purity the amount administered can be quantitatively adjusted with great accuracy.

The practical outcome is that the manufacture of ergosterol from yeast has been set up in Great Britain, and it is being irradiated commercially under proper scientific control with animal tests. Consequently vitamin D can be provided sufficient to meet the world's requirements. English manufacturers are issuing it in pellets or capsules and in oily solution, also in combination with vitamin A and malt extract, so that it is easy for all to make good the deficiency due to climatic influences during the winter months. Thus no time has been lost in applying this discovery of science to essentially practical ends.

Atoms and their Packing Fractions.[1]

By Dr. F. W. ASTON, F.R.S.

THE original mass-spectrograph was set up in the Cavendish Laboratory in 1919. Its resolving power was sufficient to separate mass lines differing by about 1 in 130, and its accuracy of measurement was about 1 in 1000. These capabilities sufficed to determine with fair certainty the isotopic constitution of more than fifty elements, and to demonstrate that, with the exception of hydrogen, the masses of all atoms could be expressed as integers on the scale O = 16 to one or two parts in one thousand. For advance in two directions of fundamental importance, namely, the resolution of the mass lines of the heavier elements and the measurement of the divergences from the whole number rule, a considerably more powerful instrument was required and has now been constructed. The increase in resolution is obtained by doubling the angles of electric and magnetic deflexion, and sharpening the lines by the use of finer slits placed farther apart. The new instrument has five times the resolving power of the old one, far more than sufficient to separate the mass lines of the heaviest element known. Its accuracy is 1 in 10,000, which is just enough to give rough first order values of the divergences from whole numbers.

Such a high order of accuracy can be attained only when lines are so near together on the mass spectrum that not only can their distance apart be determined with the highest accuracy but also the calculation of their mass difference will not be seriously affected by error in the dispersion constant. These conditions may be made use of in several different ways, as follows :

Method I.—Direct measurement on a single spectrum. This method is virtually free from all uncertainty, but can only be applied to bodies giving lines clearly resolved, but differing by less than 1 per cent. in mass. These cases are unfortunately very rare. The best example is the doublet given by oxygen-methane shown in spectra I. and IV. (Fig. 1). Here the lines only differ by 0·2 per cent. in mass, and can be obtained of equal intensity by manipulation of the quantities of oxygen and methane present in the discharge tube.

Method II., which may be called the method of series shift, can be employed whenever the masses to be compared form terms in a series the unit of difference of which is not too great. Two potentials are chosen which will bring consecutive terms into the desired contiguity, and these are applied to the electric plates alternately during the exposure while the magnetic field is kept constant. In this way irregularities in the series can be measured. A good example of this is shown in spectrum II. where the series 79, 80, 81, 82 given by bromine and its hydrides is tested in this way and the interval between Br^{79} and Br^{80} determined in terms of the hydrogen atom.

Method III. is the most generally applicable. It is the original bracketing method modified by the use of a small interval instead of a bracket. In it the lines are brought into the required contiguity by a change in the electric field, and this change is measured by means of two other mass lines of known ratio.

In the calculation of atomic masses from the ratios measured, the atom O^{16} is taken as the standard of mass. The results so far support the conclusion that oxygen is a simple element and that therefore this scale is the same as that used in chemical atomic weights.

Ever since the discovery of the whole number rule, it has been assumed that in the structure of atoms only two entities are ultimately concerned, the proton and the electron. If the additive law of mass was as true when an atomic nucleus is built of protons plus electrons as when a neutral atom is built of nucleus plus electrons, or a molecule of atoms plus atoms, the divergences from the whole number rule would be too small to be significant, and, since a neutral hydrogen atom is one proton plus one electron, the masses of all atoms would be whole numbers on the scale H = 1. The measurements made with the first mass-spectrograph were sufficiently accurate to show that this was not true. The theoretical reason adduced for this failure of the additive law is that, inside the nucleus, the protons and electrons are packed so closely together that their electromagnetic fields interfere and a certain fraction of the combined mass is destroyed, whereas outside the nucleus the distances between the charges are too great for this to happen. The mass destroyed corresponds to energy released, analogous to the heat of formation of a chemical compound ; the greater this is the more tightly are the component charges bound together and the more stable is the nucleus formed. It is for this reason that measurements of this loss of mass are of such fundamental importance, for by them we may learn something of the actual structure of the nucleus, the atomic number and the mass number being only concerned with the numbers of protons and electrons employed in its formation.

The most convenient and informative expression for the divergences of an atom from the whole number rule is the actual divergence divided by its mass number. This is the mean gain or loss of mass per proton when the nuclear packing is changed from that of oxygen to that of the atom in question. It will be called the ' packing fraction ' of the atom and expressed in parts per 10,000. Put in another way, if we suppose the whole numbers and the masses of the atoms to be plotted on a uniform logarithmic scale such that every decimetre equals a change of 1 per cent., then the packing fractions are the distances, expressed in millimetres, between the masses and the whole numbers.

In Table I. is given a list of elements on the isotopic constitution of which further light has been

[1] From the Bakerian Lecture—A New Mass-Spectrograph and the Whole Number Rule, *Proc. Roy. Soc.* A, vol. 115, p. 487, 1927, to which the reader is referred for all details of apparatus and technique.

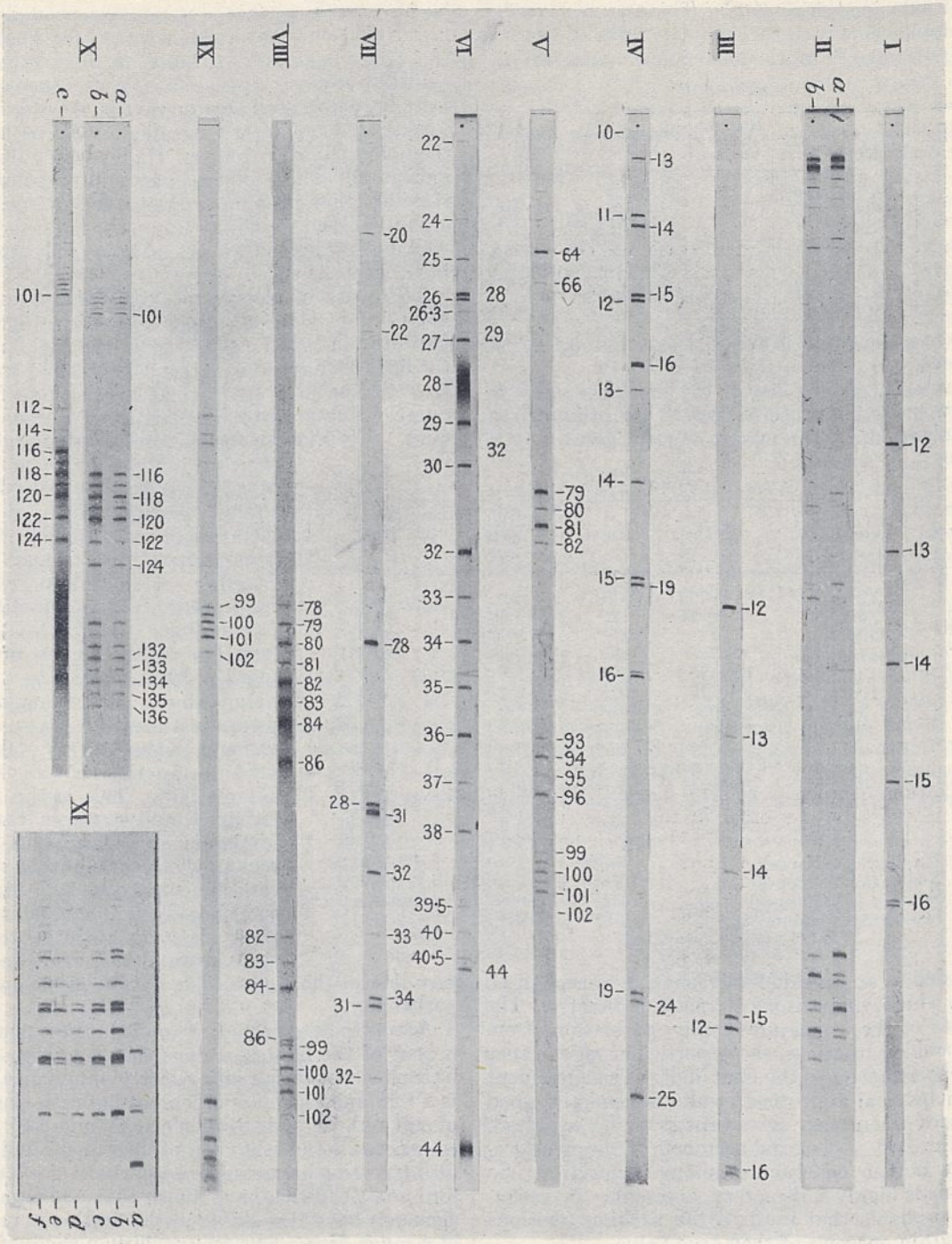

FIG. 1.—Description of the Mass-spectra reproduced.

I.—Single spectrum of the C_1 group, showing oxygen methane doublet.

II.—Double spectra illustrating comparison of Br lines by Method II.

III.—Double spectrum comparing CH_3 and C, voltages 280, 352. The oxygen methane doublet is seen on the extreme right.

IV.—Double spectrum comparing F and C_2, voltages 280, 352. This combined with III. gives the mass of fluorine in terms of carbon and hydrogen by the general Method III. The line of B^{11} can be seen and, very faintly, that of B^{10}. The oxygen methane doublet is shown very clearly in the lower potential spectrum.

V.—Single spectrum taken with CH_3Br showing the pairs of lines due to Br, HBr, CH_2Br, CH_3Br, and the second order mercury group.

VI.—Double spectrum comparing Br^{81} with CO_2, voltages 300, 324. The higher voltage spectrum, which had an exposure of half an hour, shows the triply-charged Br line at 26·3. It contains the lines of sulphur, chlorine, etc., and is an admirable illustration of the linear distribution of lines differing by one unit.

VII.—Double spectrum showing the lines of phosphorus and its hydrides photographed between the lines of carbon monoxide and phosphorus.

VIII.—Double spectrum comparing Kr^{86} with Hg^{198}. The lines of krypton are seen near the middle. The second order lines of mercury are shown under high dispersion.

IX.—Spectrum showing the second order mercury group very clearly.

X.—(*a*) and (*b*) spectra showing the even spacing of the tin monomethide and xenon lines. (*c*) The same with long exposure showing eleven isotopes of tin.

XI.—Six double spectra taken with the same voltages 360, 368. Each has an exposure suited to a particular pair of lines, for comparison of CO_2, Kr, and Br. (*a*) $Kr^{86} : CO_2$, (*b*) $Kr^{78} : Kr^{80}$ and $Kr^{80} : Kr^{82}$, (*c*) $Kr^{80} : Kr^{82}$ and $Kr^{82} : {}^{84}$, (*d*) $Kr^{82} : Kr^{84}$ (*e*) $Kr^{84} : Kr^{86}$, (*f*) after addition of methylene bromide $Br^{79} : Br^{81}$.

thrown during this research. This may be regarded as supplementary to the complete table of isotopes last published.[2] With this it forms a complete list

TABLE I.

Element.	Atomic number.	Atomic weight.	Minimum number of isotopes.	Mass numbers of isotopes in order of intensity.
S	16	32·06	3	32, 33, 34
Sn	50	118·70	11	120, 118, 116, 124, 119, 117, 122, 121, 112 114, 115
Xe	54	130·2	9	129, 132, 131, 134, 136, 128, 130, 126, 124
Hg	80	200·6	6	202, 200, 199, 198, 201, 204
Pb	82	207·2	3	208, 206, 207

of non-radioactive isotopes discovered up to the present.

Table II. gives a list of the precision measurements including those calculated for lithium from Costa's results. The margin of error given may be regarded as an outside limit, hence it is large in all cases where comparisons are made indirectly. The masses of the atoms are simply calculations from the packing fractions, so no particular significance is to be attached to the final digit. The agreement with chemical and other results is generally good in cases when such agreement is to be expected, but the best test of the accuracy of the measurements is their consistence among themselves. So far this is highly satisfactory, and makes it reasonably probable that most of the packing fractions are within one unit of their true value.

TABLE II.

Atom.	Packing fraction $\times 10^4$.	Mass O=16.	Atom.	Packing fraction $\times 10^4$.	Mass O=16.
H	$77{\cdot}8 \pm 1{\cdot}5$	1·00778	Cl^{35}	$-4{\cdot}8 \pm 1{\cdot}5$	34·983
He	$5{\cdot}4 \pm 1$	4·00216	A^{36}	$-6{\cdot}6 \pm 1{\cdot}5$	35·976
Li^6	$20{\cdot}0 \pm 3$	6·012	Cl^{37}	$-5{\cdot}0 \pm 1{\cdot}5$	36·980
Li^7	$17{\cdot}0 \pm 3$	7·012	A^{40}	$-7{\cdot}2 \pm 1$	39·971
B^{10}	$13{\cdot}5 \pm 1{\cdot}5$	10·0135	As	$-8{\cdot}8 \pm 1{\cdot}5$	74·934
B^{11}	$10{\cdot}0 \pm 1{\cdot}5$	11·0110	Kr^{78}	$-9{\cdot}4 \pm 2$	77·926
C	$3{\cdot}0 \pm 1$	12·0036	Br^{79}	$-9{\cdot}0 \pm 1{\cdot}5$	78·929
N	$5{\cdot}7 \pm 2$	14·008	Kr^{80}	$-9{\cdot}1 \pm 2$	79·926
O	0·0	16·0000	Kr^{81}	$-8{\cdot}6 \pm 1{\cdot}5$	80·926
F	$0{\cdot}0 \pm 1$	19·0000	Kr^{82}	$-8{\cdot}8 \pm 1{\cdot}5$	81·927
Ne^{20}	$0{\cdot}2 \pm 1$	20·0004	Kr^{83}	$-8{\cdot}7 \pm 1{\cdot}5$	82·927
Ne^{22}	(2·2 ?)	22·0048)	Kr^{84}	$-8{\cdot}5 \pm 1{\cdot}5$	83·928
P	$-5{\cdot}6 \pm 1{\cdot}5$	30·9825	Kr^{86}	$-8{\cdot}2 \pm 1{\cdot}5$	85·929
			I	$-5{\cdot}3 \pm 2$	126·932
Tin (eleven isotopes) . . .			Sn^{120}	$-7{\cdot}3 \pm 2$	119·912
Xenon (nine isotopes) . . .			Xe^{134}	$-5{\cdot}3 \pm 2$	133·929
Mercury (six isotopes) . .			Hg^{200}	$+0{\cdot}8 \pm 2$	200·016
Lead (three isotopes) . . .			Pb^{206}	$+0{\cdot}8 \pm 2$	206·016

As has already been explained, in addition to the first two fundamental constants of an atom, atomic number and mass number, which settle the numbers of protons and electrons contained in its nucleus, we now have a third, the packing fraction, which gives entirely new information on the nucleus, for it is a measure of the forces binding those protons and electrons together. The discriminating value of this information is clear at once: for example, had the packing fraction of the helium atom not been greater than that of the oxygen atom it would have ruled out the possibility that the nucleus of the latter was simply built of four unchanged helium nuclei or alpha particles, for there would have been no loss of energy, that is, mass defect, in the latter to represent the binding forces holding the four particles together. High packing fractions indicate looseness of packing, and therefore low stability: low packing fractions the reverse. We are at once led to inquire into what happens to the packing fraction as we ascend from atom to atom in the scale of mass.

The result of plotting packing fractions against mass numbers for all atoms so far investigated is indicated in Fig. 2. Fig. 3 gives the same plot for the light elements on a larger scale. These indicate that the packing fraction as a function of mass number shows simple regularities of a remarkable kind. If we ignore for the present the large gaps which it is hoped to bridge as the work proceeds, it appears that all atoms, except those of light elements of even atomic number, approximate to a single curve. Starting at hydrogen with a large positive packing fraction, the curve drops rapidly, crosses the zero line in the region of mass number 20 and sinks to a minimum value. Very recent experiments with nickel give a provisional value -10 for the packing fraction of its lighter isotope Ni^{58}. This is the lowest obtained, and suggests that the minimum is in the iron nickel region, which may have a significance in connexion with the presumed geological abundance of these elements. The curve then rises again and recrosses the zero line in the region 200. There is no marked periodicity.

As was to be expected, the most interesting region is that of the lightest atoms, shown in Fig. 3. In isotopic constitution and relative abundance there is a fundamental class difference between elements of odd and elements of even atomic number.[3] This is reflected in the behaviour of their nuclei under the disintegrating impact of alpha particles, for Rutherford and Chadwick have shown that odd numbered elements have less stable nuclei and emit protons at a much higher average speed than those of even number. This difference is now shown to extend to their nuclear masses. Whereas the atoms of odd atomic number, irrespective of whether their mass number is odd or even, approximate to a smooth curve rising steeply to hydrogen, those of even atomic number lie well below and may be said to form a branch rising less steeply to helium. For comparison, the rectangular hyperbola $x\ (y+12{\cdot}5)=250$ has been drawn in Fig. 3. Such a curve is the locus of the packing

[2] F. W. Aston, *Phil. Mag.*, vol. 49, p. 1199 (1925).

[3] See "Isotopes," 2nd edition, p. 131.

fractions atoms of mass = mass number + 1/40 unit, if O = 16 $(1 + 12{\cdot}5 \times 10^{-4})$.*

In the cases of atoms of odd atomic number the measurements show a definite approximation to this curve. This means that the masses of the nuclei of these particular atoms can be regarded as being made up of two distinct parts, one which changes by unity for each unit advance in mass number, and another, a small excess, which remains constant. To illustrate this point we may imagine the nuclei of these atoms to consist of a central core of maximum tightness of packing, corresponding to a packing fraction on the oxygen scale of $-12{\cdot}5$, which is surrounded by, let us say, three protons or neutrons attached with a tightness represented by a packing fraction 83·3. That is to say, these three bodies will together account for the excess 1/40 unit. The free proton has a packing fraction on the new scale of $77{\cdot}8 + 12{\cdot}5 = 90{\cdot}3$ which leaves a balance of 7 for binding purposes in each case.

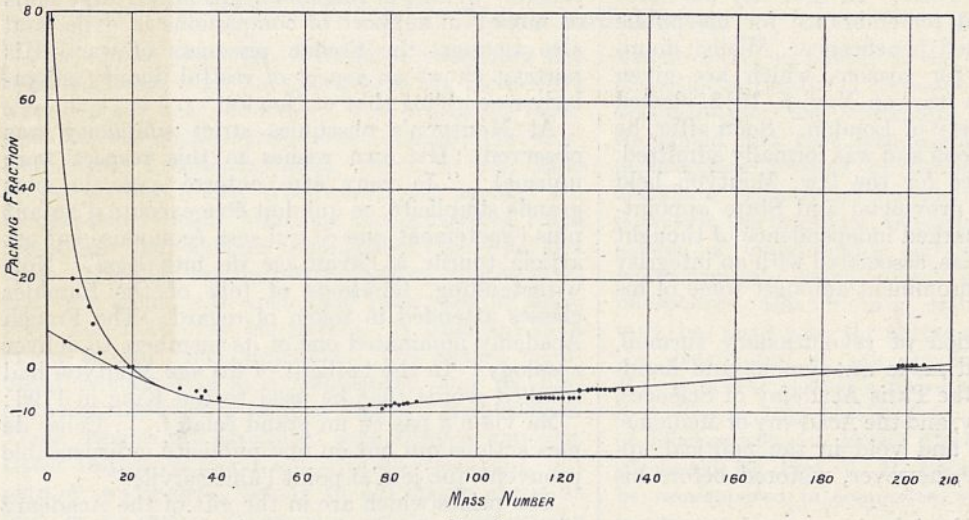

FIG. 2

No stress is to be laid on these figures, which are purely illustrative, nor is it intended to discuss the possibilities in any detail at present, but the facts do certainly suggest that the nuclei of light atoms have a loose, and therefore heavy, external structure of lightly bound protons or neutrons common to them but not possessed by the much more stable and tightly bound atoms of helium, carbon, and oxygen. Whether this is so or not, the position of carbon and oxygen on the diagram indicates a tightness of packing entirely in favour of the views of Rutherford and Chadwick as against those of Kirsch and Pettersson, who claim that protons can be detached from these nuclei by the impact of alpha rays. Neither do the observations of Rutherford and Chadwick that the chance of disruption of protons from lithium atoms, if possible at all, is small compared with those of boron, nitrogen, etc., show any serious discordance with Costa's results for lithium, here plotted, for the position of these suggests that their nuclear structure, though loose, is not so loose as that of the others. It is unfortunate in this connexion that data for beryllium are not available.

The fact that the packing fractions of the heavier atoms show a smooth distribution and do not decrease continually with increase of mass number is interesting. It is not what one would expect were the nucleus a structure similar to the outside of the atom, and possessing a periodic function. It is much more in keeping with the view put forward by Sir Ernest Rutherford[4]—that the nucleus consists of an inner part of uniform, tightly bound

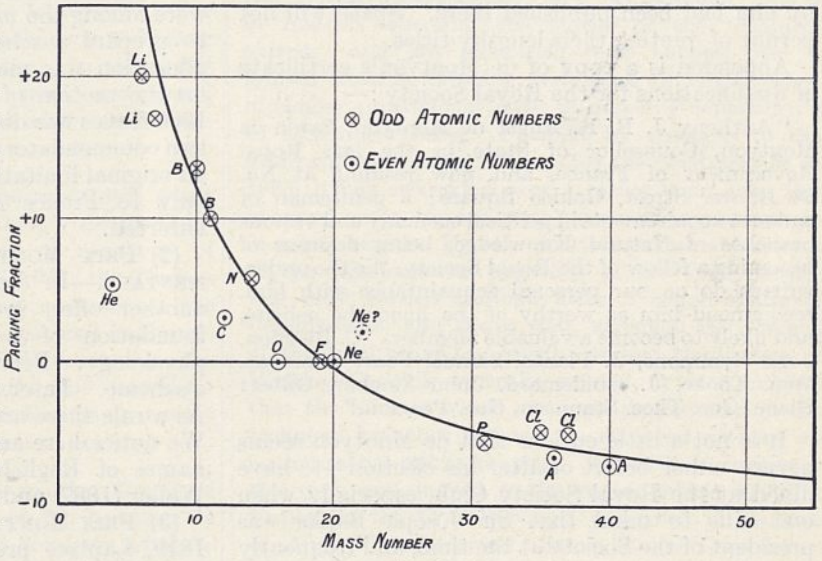

FIG. 3.

'crystalline' structure, outside which is a looser system of neutrons, protons, and electrons which is more complex the heavier the element. The crystalline packing supplies a minimum possible packing fraction, while the increasingly complex outer structure may be taken to explain the rise of the packing fraction in very heavy elements.

* The plus sign within the brackets was misprinted as minus in Bakerian Lecture.

[4] Guthrie Lecture of the Physical Society of London, 1927.

Baron de Montyon, F.R.S. (1733–1820), and the Paris Academy of Sciences.

ANTOINE JEAN BAPTISTE ROBERT AUGET, Baron de Montyon, economist and philanthropist, was born at Paris on Dec. 23, 1733, and he died there on Dec. 29, 1820, at the age of eighty-seven years. In that city his name is held in honoured remembrance for his public work and enlightened beneficence. Whilst domiciled in England—for reasons which are given below—de Montyon was, on Nov. 5, 1812, elected into the Royal Society of London. Soon after, he signed the charter book and was formally admitted.

Trained in France for the law, Montyon held various important provincial and State appointments, exhibiting marked independence of thought and freedom from bias, associated with an integrity certainly none too prominent amongst some of his contemporaries.

Prior to the period of revolutionary turmoil, M. de Montyon had made anonymous and handsome donations to the Paris Academy of Sciences, the French Academy, and the Academy of Medicine. These became null and void in the political upheaval. They were, however, restored before his death.

De Montyon, rich by inheritance, and disinclined to parley with any new regime, emigrated in 1792, settling for a time at Geneva, afterwards transferring to London. He did not return to Paris until 1815, being then eighty-two years old. Count Rumford had died in the previous year; Davy was then thirty-seven years old. The English journals of the period of de Montyon's residence in London are provokingly silent, although two works by him had been published there. Space will not permit of quoting their lengthy titles.

Appended is a copy of de Montyon's certificate of qualifications for the Royal Society :—

"Anthony J. B. R. Auget de Montyon, Baron de Montyon, Counsellor of State in the late Royal Government of France, and now residing at No. 38 Brewer Street, Golden Square; a gentleman of eminent acquirements in political economy and various branches of Natural Knowledge, being desirous of becoming a fellow of the Royal Society, We the underwritten do on our personal acquaintance with him, recommend him as worthy of the honor he solicits, and likely to become a valuable Member. C. Blagden, John Symmons, J. Planta, Samuel Foart Simmons, Wm. Tooke, J. Guillemard, John Sinclair, Gilbert Blane, Geo. Thos. Staunton, Geo. Pearson."

It is not a little curious that de Montyon seems never—either before or after his election—to have dined at the Royal Society Club, especially when one calls to mind that Sir Joseph Banks was president of the Society at the time, and frequently introduced foreigners of distinction. M. Coquebert de Montbret, a compatriot, was among these, and he dined, so Sir Archibald Geikie has told us, on four occasions after 1809. Here it may be interpolated that de Montbret was, with Laplace and Fourier, on a commission for the institution of the Montyon prize in statistics (1817). Doubtless sufficient reason is found in the quietness of Montyon's life, necessitated by the circumstances of exile. Moreover, he had never sought the fashionable world, preferring the society of men of letters. It is recorded that he was a good conversationalist, and prolific in attractive reminiscences. Whilst in England he disbursed large sums of money in support of companions in exile, and also amongst the French prisoners of war. His portrait shows an aspect of restful dignity, singularly resembling that of Newton.

At Montyon's obsequies strict simplicity was observed. His own wishes in this respect were unusual: "Je veux être enterré avec la plus grande simplicité, ce qui doit être exécuté d'autant plus exactement que ce qui sera économisé sur cet article tourne à l'avantage de mes legs." Notwithstanding, hundreds of folk of the humbler classes attended in token of regard. The French Academy nominated one of its members to deliver a eulogy. In the twilight of his age Montyon had recalled words that he used to the King in 1796: "Ma vie n'a pas eu un grand éclat. . . . Celles de mes actions qui ont eu une publicité indispensable prouvent que je n'ai point l'âme servile."

The prizes which are in the gift of the Academy of Sciences are enumerated below; and some notes added indicate slight variations which have followed their institution.

(1) PRIX MONTYON DE STATISTIQUE.—At a meeting of the Academy in September 1817, Laplace informed his colleagues of an anonymous offer of a capital sum of 7000 francs for the establishment of an annual prize for statistical researches. Acceptance followed, and Laplace, Montbret, and Fourier were among the members of a commission charged to prepare a scheme of management. The first allocation was made in 1819. In the year 1910, on the motion of M. Gaston Darboux, a sum of 1000 francs was decided on as the primary gift, with two commendatory awards of 500 francs. Further, an original limitation that the research should refer only to France and her colonies, is no longer enforced.

(2) PRIX MONTYON DE PHYSIOLOGIE EXPÉRIMENTALE.—In June 1818 the Academy received another offer, in similar circumstances, for the foundation of a yearly prize in experimental physiology. Berthollet, Hallé, and others drew up a scheme. Later, the donor supplemented the gift. As a rule there are two awards of 750 francs each. We notice here and there in the list of awards the names of Englishmen, for example: Dr. A. D. Waller (1887) and Dr. A. B. Griffiths (1893).

(3) PRIX MONTYON DE MÉCANIQUE.—In August 1819, Laplace presented a note designating this annual prize, and from the same source. The attribution is now 750 francs. In exact terms the gift is for . . . "instruments utiles aux progrès de l'agriculture, des arts mécaniques et des sciences pratiques et spéculatives."

(4) PRIX MONTYON DE MÉDECINE ET CHIRURGIE ET PRIX MONTYON DES ARTS INSALUBRES.—This conjoint prize was dedicated by the terms of Baron Montyon's will, under date Nov. 12, 1819. There

were other and large benefactions, which, however, are outside the scope of this notice. The first prize was given in 1825. A commission had formulated regulations, and amongst the members were Cuvier, Fourier, and Berthollet. The terms of the award are of wide application, whilst the prizes are open to persons of all nationalities. In the first section are three yearly gifts of 2500 francs, and three *mentions honorables* of 1500 francs. In the second section (in effect, chemistry) there is a prize of 2500 francs, with a second of 1500 francs for meritorious entry. T. E. JAMES.

News and Views.

FOR several years Dr. Wilhelm Freudenberg has collected fossils from the sand-pits in the Pleistocene river deposits near Heidelberg, from which the lower jaw of *Homo heidelbergensis* was obtained. We now learn, from a communication which he has made to Sir Arthur Smith Woodward, that among the mammalian remains which he has discovered there are no less than eighteen fragments of fossil man and apes. The tibia ascribed to Heidelberg man is short and very stout, with an inward twist, and in many ways like that of a big gorilla. A fragment of a femur is also very gorilla-like. The second metatarsal is curved as in a chimpanzee, and the first metacarpal is twice as large as that of a modern man. These remains are associated with *Elephas antiquus*. Other fragments found not with this elephant, but with *E. trogontherii*, belong to a Primate about as large as an orang. There is a sagittal crest on the parietal bone, and a piece of lower jaw resembles that of Sivapithecus rather than Dryopithecus. The pelvis shows several features of that of a chimpanzee, and the femur and tibia are slender. Other fragments of the same age belong to two smaller Primates related to the gibbons. They seem to have had comparatively small canine teeth. In association with them, one long and remarkably human femur, an apparently human pubis, and a human navicular bone, are considered by Dr. Freudenberg to belong to a forerunner of Neanderthal man. In the upper beds, with *Rhinoceros etruscus*, were also found implements of quartzite, charcoal, and burnt fragments of bone.

PALÆONTOLOGISTS and anthropologists will await with great interest Dr. Freudenberg's detailed description of his finds. Remains of monkeys of Pleistocene age are known from Norfolk, the Thames valley, France, and Germany, but no trace of the man-like apes has hitherto been discovered in Europe of later date than the Lower Pliocene. If Dr. Freudenberg's results are confirmed, the search for the earliest ancestors of man in Europe is not so hopeless as it is commonly supposed to be.

THE retirement is announced in the *Lancet* of Dr. A. B. Macallum, professor of biochemistry in McGill University, Montreal, and formerly administrative chairman of the Honorary Advisory Council for Scientific and Industrial Research, Canada. Prof. Macallum, who was successively lecturer and professor in physiology and later professor of biochemistry in the University of Toronto, introduced a full experimental course in physiology at Toronto so long ago as 1886; at that time, no similar course for students was anywhere in existence. His research work at first was devoted particularly to the origin of hæmoglobin from the chromatin of hæmatoblasts. This led to a demonstration that chromatin is an iron-holding compound and that hæmoglobin is, as it were, a degeneration product of chromatin. Later, Prof. Macallum investigated the absorption of iron compounds in the intestines, the composition of the blood plasma of invertebrates and vertebrates, and the microchemical detection of potassium, chlorine, phosphorus, calcium, iron, and copper. His latest work has dealt with the effects of surface tension on the distribution of salts in living matter. Prof. Macallum was elected a fellow of the Royal Society in 1906; in 1920 he left Toronto to take the chair of biochemistry at McGill University. He will be succeeded by Prof. J. B. Collip, whose name will be remembered in connexion with the discovery of insulin.

THE honorary secretary of the Institution of Professional Civil Servants writes to inform us that the leading article on "The Technical Expert in the Civil Service," published in our issue of Dec. 10, has been welcomed by the professional group of civil servants. He directs attention also to the fact that, since its foundation in January 1919, the Institution has worked energetically for "a thorough reform in matters affecting the status of the technical expert," and has met with some success over a limited area in bringing conditions of employment of similar professional staffs in different departments to a uniform basis. Further, by recourse to the arbitration machinery set up for the Civil Service in 1925, it has succeeded over a rather wide area, but in many cases, in obtaining piecemeal improvements in salary scales. He also points out that the reform of the non-technical branches of the Civil Service was only carried through after a series of Royal Commissions, and states that, although the Council of the Institution has loyally worked the system of Whitley Councils recently created, it is convinced that the reforms which are urgently required in the technical branches will not be achieved without an authoritative public inquiry. We entirely concur in this view, and, indeed, in the leading article on "The Expert in the Civil Service" published in NATURE of Aug. 27 last, urged that a Royal Commission should be appointed to examine into and report on the present position of professional workers in the State service. We are of opinion that the need for modifications of the present Civil Service system is of pressing importance, and that in the interest of both efficiency and economy no time should be lost in providing for a comprehensive inquiry of the nature indicated.

SPEAKING at Sexey's School, Bruton, Somerset, on Speech Day, Prof. John Read, professor of chemistry at the University of St. Andrews, directed the attention of the boys of his old school to some of the qualities which scientific training educed: honesty, perseverance, precision, the co-ordination of hand, eye, and brain, the development of logical methods, and the recognition of the importance of small things. Whilst confessing his enthusiasm for literary pursuits, he urged them not to be misled by references to the 'dry bones' of science, or to imagine that the man of science is less human or humane than his brethren; there is need to emphasise this in an age when no man can claim to be truly educated unless he possesses a knowledge of the general principles of physical science and comprehends how a plant grows and how an animal lives. Discussing the ever-expanding part which science is playing in the industrial and economic development of the British Empire, Prof. Read referred to the activities of Imperial Chemical Industries, Ltd., and particularly to its progress in rendering Great Britain less dependent on imported liquid fuels and fixed nitrogen, and to its assistance in the development of agriculture. Prof. Read also addressed the school literary and debating society on the contribution of organic chemistry to the progress of civilisation, the title of his lecture being "An Organic Chemist looks at the World"; he referred on this occasion to the non-permanence of coal and oil as sources of energy and to their possible replacement by alcohol, which can be produced in unlimited quantity so long as the sun shines and plants grow. Mention was also made of the low-temperature distillation of coal, and of the value of brown coal as a source of energy.

AT a meeting held at the Imperial College of Science in February last, it was agreed to form a society for the purpose of studying bibliographical methods and securing unity of bibliographical procedure and classification. The first meeting of the Society was held at the Science Library, South Kensington, on Dec. 13, thirteen members being present. The objects of the Society were defined as follows: "To promote the study of bibliographical methods and of the classification of information, to secure international unity of bibliographical procedure and classification, and to foster the formation of comprehensive and specialist bibliographies of recorded information." The name adopted for the Society was "The British Society for International Bibliography." As the Society has been adopted as the British Section of the Institut International de Bibliographie, it is proposed to use the sub-title "British Section of the I.I.B." if necessary. Prof. Alan Pollard, of the Imperial College, was appointed president, with Dr. S. C. Bradford, of the Science Library, as vice-president, and Dr. Walter Clark, also of the Science Library, as honorary secretary. The other members of the council are Miss Snelus, Messrs. P. K. Turner, A. Esdaile, and T. Smith. At the VI^e Conférence Bibliographique Internationale, held in Brussels in July last, it was agreed to confer the presidency of the Institut International de Bibliographie upon Great Britain for the year 1927–28, and the British Society for International Bibliography was invited to nominate the president. It has proposed the name of Prof. Pollard. The Society is prepared to receive all criticisms and suggestions for the development of the Classification Décimale of the Institut International de Bibliographie, and to transmit recommendations to the Institute. All particulars concerning the Society, the Institut International de Bibliographie, and the Classification Décimale may be obtained from Dr. Clark, hon. secretary of the Society.

A MACHINE which is capable of turning out one million pint bottles a week, and requires only one man to superintend its operation, is surely a remarkable achievement. Such is the machine recently constructed by the Metropolitan-Vickers Electrical Co., Ltd., at its works in Manchester (Fig. 1). The glass is melted in pots or in a tank furnace and the machine is run on rails to the mouth of the furnace. A small 15-h.p. electric motor is started and bottles are automatically turned out in dual moulds at the above rate. The machine consists of fifteen identical

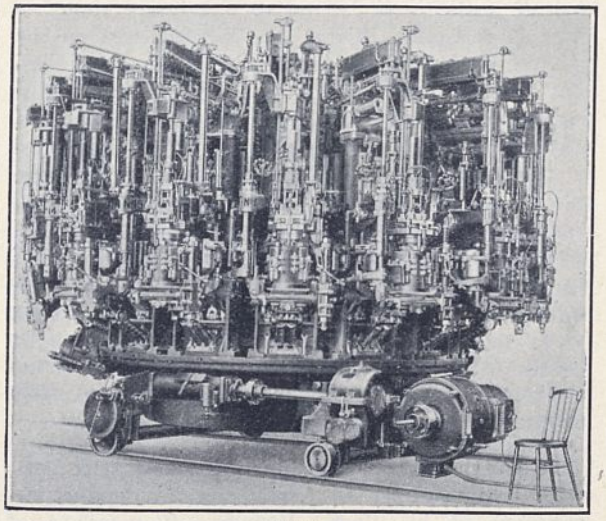

FIG. 1.

units which rotate around a central pillar. In the event of a breakdown of any one unit, it can be replaced in less than thirty minutes. As each unit passes the mouth of the furnace, huge arms are lowered into the molten glass, a quantity of which is picked up in a mould by means of suction. A small quantity of compressed air is then admitted to form a cavity in the neck of the bottle. Further rotation of the machine, which has a speed of six revolutions per minute, enables the glass blank thus formed to be transferred to a second mould, the interior of which is of the shape of the finished bottle. A further supply of compressed air blows the bottle to the shape of the mould. The machine moves on to the next stage, when the moulds are lowered and the bottles are automatically discharged on to a conveyor. In addition to the manufacture of bottles, this machine is equally useful for the manufacture of electric lamps

or other articles of a similar nature and is entirely a British production. It is a great improvement over previous machines, most of which are of foreign manufacture. For a complete illustrated description of the machine, reference should be made to the *Engineer* of July 1 and 8, 1927.

MR. L. J. KETTLE, the electrical engineer to the Dublin Corporation, gave an interesting address to the Irish local centre of the Institution of Electrical Engineers on Oct. 13. He pointed out that the Electricity (Supply) Act, 1927, of the Irish Free State gives practically unlimited power to the Irish Electricity Supply Board. One of its duties is to investigate the natural power resources of the Free State. Towards the end of the War, some work in this direction was done by the British Government. Mr. Kettle regards peat as the greatest potential power asset. Six million tons of air-dried peat are at present dug out and used per annum in Ireland. The fuel equivalent of this peat is equal to that of the whole of the coal imported per annum into the Free State. With a little State assistance and encouragement the output could be materially increased. Even if the increase were only ten per cent., it would be equivalent to all the power to be obtained initially from the River Shannon. Mr. Kettle is strongly of opinion that a comprehensive water-power survey of Ireland should be made as soon as possible. It is quite conceivable that the by-products of a peat power station would more than cover all the costs of production, and thus the electric power generated would cost nothing. He urged that the Electricity Board should completely equip the model farm near Dublin with all manner of electric labour-saving devices. It would be a valuable demonstration and training centre for the propagandists who are anxious to see the whole country electrified. He pointed out that the actual production costs are now of secondary importance, owing to the large number of middlemen interposed between the manufacturer and the consumer. His cure for this state of affairs is to return to the old village industry system. He considers that a return to this system may be feasible in Ireland.

MR. C. C. PATERSON, Director of the Research Laboratories of the General Electric Co., Ltd., gave an interesting address to the London Section of the Institute of Metals on Nov. 10. He pointed out that the cost of conducting materials is one of the heaviest items of expenditure in the electrical industry. For long-distance power transmission it is nearly half the total cost. In addition, it is now becoming common practice to use tubular conductors in order to prevent the formation of the corona. This adds to the expense. It is not beyond the bounds of possibility that metallurgical research will yield a high conductivity alloy which will replace copper. The possibilities of the lighter metals like beryllium and aluminium when alloyed have not yet been fully investigated. So far as the magnetic qualities of metals are concerned, it looks as if the manufacturing departments lag behind laboratory research, at least so far as heat treatment and new methods are concerned. Practical men now recognise the great importance of the presence of gases in metals like nickel and tungsten which are used in the manufacture of electric lamps. Commercially pure metals from the factory are quite unsuitable for lamp manufacture. A two-hour treatment in 'a vacuum' is necessary until the pressure falls to 0·004 mm. of mercury. It would be a great boon to the electrical industry if the metallurgist could produce an alloy in the form of wire which would keep its homogeneous nature, and retain its qualities however long it was subjected to the action of heat. In other words, it must remain stable and not develop local hot spots when heated by an electric current. It is of great importance to devise tests on the effects of heating on various alloys so as to enable the purchaser to get the most economical material. At the Research Laboratories of the General Electric Co., Ltd., at Wembley, experiments are being carried out on various test methods.

IT is announced that Sir Ernest Rutherford has been elected a foreign associate of the Paris Academy of Sciences. The foreign associates of the Academy are limited in number to twelve, and include Sir Ray Lankester, elected in 1910, and Sir J. J. Thomson, elected in 1919.

THE Catherine Wolfe Bruce gold medal of the Astronomical Society of the Pacific, given annually for "distinguished services to astronomy" upon the nominations made by six of the world's great observatories, has been awarded for 1928 to Dr. W. S. Adams, Director of the Mount Wilson Observatory. The formal presentation will be made in the early part of next year. Previous recipients have included Prof. E. W. Brown, M. Henri A. Deslandres, Sir Frank W. Dyson, M. E. B. Baillaud, Prof. A. S. Eddington, and Prof. H. H. Turner.

AT a special general meeting of the Institute of Physics, held on Dec. 16, and on the recommendation of the Board, the Royal Meteorological Society was admitted a participating society of the Institute. The Royal Meteorological Society is the sixth society to co-operate in the scheme of participation, and an important step is thus taken towards the realisation of one of the principal objects of the Institute, as expressed at its foundation, namely, to co-ordinate the work of all existing societies concerned with the science of physics and its applications.

COL. CHARLES LINDBERGH has been awarded the Langley Medal for Aerodromics of the Smithsonian Institution of Washington, "in recognition of his daring non-stop flight from New York to Paris on May 20 and 21, 1927." Established in 1909 in honour of Samuel Pierpont Langley, third secretary of the Smithsonian Institution, who was the first man in the world to make a large model heavier-than-air machine fly successfully under its own power, the medal has been awarded hitherto to four men: Wilbur and Orville Wright, Glenn H. Curtiss, and

Gustave Eiffel. Col. Lindbergh stated that it has been decided to offer his machine, *Spirit of St. Louis*, to the Smithsonian Institution to be added to the collection of aeroplanes of historic interest that it possesses.

THE annual report of the Rockefeller Foundation for 1926 has recently been issued. During that year the Foundation expended 9,741,474 dollars on medical research and the prevention of disease in all parts of the world. The activities of the Foundation are reviewed by the president, Dr. George E. Vincent, in this report, which is illustrated with relevant maps, charts, and photographs.

IN connexion with the work of the Colorimetry Section of the U.S. Bureau of Standards and the report of the Colorimetry Committee of the Optical Society of America, Mr. Irwin G. Priest is desirous of compiling a bibliography of papers and books having a direct bearing on colorimetry, spectrophotometry, and colour specifications. It is expected that this bibliography will ultimately be published in the *Journal of the Optical Society*. He will be glad if authors who have contributed to this subject will send him check lists of their papers, giving titles and complete journal references. Reprints will also be of service and will be gratefully received. Mr. Priest's address is Bureau of Standards, Washington, D.C.

MESSRS. Gurney and Jackson will publish shortly "A Popular Handbook of Indian Birds," by H. Whistler, illustrated by many coloured and black-and-white plates and text figures by H. Grönvold.

THE latest catalogue (No. 503) of Messrs. Francis Edwards, Ltd., 83 High Street, Marylebone, W.1, although mainly of a general character, contains sections devoted to geography and travel, botany and gardening, entomology, folklore, and natural history. It should therefore be of interest to readers of NATURE.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned :—An assistant lecturer in agricultural chemistry at the East Anglian Institute of Agriculture, Chelmsford—The Clerk of the Essex County Council, Shire Hall, Chelmsford (Jan. 9). A science master for physics and chemistry at the Longton High School—The Director of Education, Town Hall, Hanley, Stoke-on-Trent (Jan. 21). A reader in chemistry at Bedford College for Women—The Academic Registrar, University of London, South Kensington, S.W.7 (Feb. 17). A rubber technologist to take charge of the rubber section of a government laboratory—The Commandant, Experimental Station, Porton, Wilts. A lecturer in biology at the Saffron Walden Training College for Women Teachers—The Principal, Training College for Women Teachers, Saffron Walden.

Our Astronomical Column.

THE SPECTRUM OF THE COMET PONS-WINNECKE.—Two papers on this subject have recently appeared. Dr. G. Shajn (*Mon. Not. Roy. Ast. Soc.*, Supp.) gives diagrams showing the changes in the relative strength of different bands. At the end of May the band at λ388 was the brightest, those at λ405 and λ469 being in order of lessening brightness. The first band remained stationary for a week and then got decidedly fainter ; while the other two brightened, that at λ469 being the brightest at the end of June. The continuous spectrum was not visible at the end of May, but gradually grew in strength after this. There was more increase of light visually than photographically, implying a change of colour from blue to yellow.

Lowell Obs. Bull. No. 86 contains a discussion by V. M. Slipher of spectrograms obtained on June 20 and 23. The continuous spectrum was then strong and showed the solar absorption lines, indicating that the nucleus was shining by reflected sunlight. The Swan spectrum was weak ; there were strong cyanogen bands at λ3883 and λ4216, but the strongest bands were an unidentified series between λ3993 and λ4075. The spray of light towards the sun was the most emissive region.

This paper, like that of M. Baldet recently noticed in this column, directs attention to the remarkably small size of the stellar nucleus. The estimate at the Lowell Observatory gave a linear diameter of two or three miles, that of M. Baldet being less than a mile.

MEASURES OF DOUBLE STARS.—Prof. G. van Biesbroeck, in addition to his cometary work, undertakes a large amount of double-star observation with the 40-inch refractor at Yerkes Observatory. Vol. 5, part 1, of its *Publications* contains his measures of some 3000 stars, the majority of which are stars the duplicity of which was discovered by Prof. Hussey about the beginning of the century. The old and new measures are compared, and wherever sensible change appears an estimate is made of the hypothetical parallax, both on the assumption of a uniform mass double that of the sun, and also from the Eddington curve connecting mass with absolute magnitude. He also discusses the errors of published orbits and deduces many new ones.

One of the stars is the long-period variable X Ophiuchi, which has an unchanging 8·9 mag. companion at a distance of $\frac{1}{4}''$. Its hypothetical parallax is 0″·007, in good agreement with Adams's spectroscopic value 0″·005 from the unchanging component, the type of which is K0. It is noted that the trigonometrical measures published by van Maanen and Gringrich are probably affected by the apparent shift of the combined star-image due to the change in light. There is a new orbit given for λ Ophiuchi, rejecting the W. Herschel observations, which appear to be affected by some error. The period comes out as 150 years. The same period is suggested for 37 Pegasi, the orbit of which is turned edgewise to us. There are numerous observations of 70 Ophiuchi ; Prof. van Biesbroeck thinks that the evidence for an unseen companion is not convincing.

THE SCHWASSMANN-WACHMANN NOVA.—The Harvard storehouse of plates has once again proved of great service in tracing the behaviour of this Nova before its discovery. Miss Cannon publishes the following details in *Harvard Announcement Card*, No. 37. It was invisible (less than mag. 15) in plates of previous years ; it first appears on Sept. 11 last, mag. 11·7 ; it rose to a maximum of 6·0 on Sept. 30 ; it had fallen to 7·4 on Oct. 16, to 8·4 on Oct. 29, to 9·4 on Nov. 19. Its spectrum was photographed with the 24-inch reflector on Nov. 20 ; the hydrogen lines were bright, the line at 4640 being five times as bright as $H\beta$.

Research Items.

THE MAORI PA.—*Bulletin* No. 6 of the Dominion Museum, New Zealand, is an elaborate account of the Maori *pa* or fort by Mr. Elsdon Best, which, in addition to a generalised description of form, method of construction, and use, deals with a number of the old *pas*, though his list does not profess to be exhaustive. In no other part of Polynesia did the fortified village obtain to the extent it did in North Island of New Zealand, and although we hear of strongholds, of which those of Tonga most nearly resemble the Maori *pa*, nowhere do we find these used more or less permanently as they were in New Zealand. In various islands from the Philippines to Hawaii at intervals, some form of defensive work in stone, timber, or earth is found; but the custom of living in these fortified villages seems to have been inherited from the first inhabitants of New Zealand, where, apparently, it was a very ancient institution. According to tradition, when Toi first reached New Zealand in the middle of the twelfth century, the Maori found the earlier peoples already using this form of defensive work, and they may have adopted it from them. It may have been spread to other parts by the intercourse between New Zealand and the other islands.

BIRD MALARIA.—The Department of Medical Zoology, School of Hygiene, Johns Hopkins University, is continuing, among other lines of work, the investigation of bird malaria. Dr. E. Hartman (*Amer. Jour. Hyg.*, **7**, No. 4, 1927) publishes the results of biometric studies on *Plasmodium præcox* in the canary. During the rise of the infection in the canary, the asexual forms of the parasite continue to die throughout the cycle. The mortality rate is during 21 hours a mathematical constant, as determined by the fit of the data to an exponential curve. The finding of Mrs. Taliaferro was confirmed, that there is a constant rate of increase in numbers of the parasites from day to day until near the peak of the infection. Some cases show a constant rate of decrease of the number of parasites as the infection declines. The relapse cases show the same characteristics of constant rates of increase and of decrease as are exhibited by primary attacks. Relapses may be either more severe or more mild than the initial attack, but they are identical in type of infection. Relapse in bird malaria is usually milder than the primary attack. Symptoms in the bird follow sporulation and peak in numbers. Dr. Mary Stuart MacDougall (in the same journal, No. 5) presents a record of experiments indicating that the increase of the sugar content of the blood brings about a condition favourable for the parasite in bird malaria, and a decrease in the blood sugar by the use of insulin creates a condition unfavourable for the parasite.

SELF-FERTILISATION IN OLIGOCHÆTES.—During investigations on *Tubifex tubifex*, L. Cernosvitov (*Biol. Zentralbl.*, Bd. 47, p. 587, 1927) observed specimens in which the spermathecæ were absent. Such worms were, of course, incapable of receiving sperms during copulation. The presence or absence of spermathecæ or the presence of spermatophores in the spermathecæ is easily ascertained in *T. tubifex*, owing to the transparency of the body wall of the tenth segment in which the spermathecæ are situated. The proportion of worms without spermathecæ varies greatly. It is low (up to 6 per cent.) in collections made in localities where the worms are found in large masses and where the individuals are 8-10 cm. long, that is, under favourable conditions of growth. In another locality where the worms did not exceed 3·5 cm. in length, the percentage without spermathecæ reached 55 to 70, and in another collection of smaller worms all the specimens were abnormal. The author concludes that unfavourable conditions lead to anomalies in the reproductive apparatus. He isolated worms without spermathecæ and also worms which possessed spermathecæ, but in which no spermatophores were present, and in both cases the worms produced eggs which developed normally. Either self-fertilisation or parthenogenesis must therefore have occurred. As there was no difference in the number of chromosomes, he assumed that self-fertilisation had taken place, but in what manner was not ascertained. The author gives the number of chromosomes as not exceeding 76, as against the number 110 stated by Gathy.

FISHES OF THE CONGO BASIN.—In a recent report (*Sitzungsberichte Akad. Wissensch. Wien*, Band 136, Heft 5 and 6) M. Holly continues his descriptions of fishes collected by Dr. Haberer in 1907–8 in the south-east Cameroons. It contains the Siluridæ, Cyprinodontidæ, Acanthopterygii, and the Mastacembelidæ, taken in the Maka district which lies between the Bumba and Ja Rivers, both tributaries of the Congo. The collection has since lain in the Natural History Museum at Vienna. Four new siluroids and one new cichlid are recorded, fully described and figured. The author disagrees with Boulenger on some minor points in the descriptions of other species.

PLAGIOTROPISM.—This tendency of many plant organs to grow horizontally, or at a definite angle to the vertical, is regarded by W. Zimmermann as a 'plagiogeotropism.' He gives a very clear account of his recent experiments in *Die Naturwissenschaften* for Nov. 11, his original paper having appeared in the *Jahrb. für wiss. Bot.*, **66**, 1927. Experimenting mainly with certain runners, such as those of the strawberry and *Ranunculus repens*, which can be grown fairly well in darkness, he shows that the position of the runner is determined by gravity, and that the angle to the vertical the runner assumes depends upon the algebraic sum of two internal (positive and negative) geotropic responses of the same organ. As these two opposite responses are not usually of equal strength and are not both at their maximum intensity when the organ is in the horizontal position, the result is a tendency to assume a definite angle in relation to the vertical, which is usually other than 90°, so that the organ grows at an angle to the horizontal. These views certainly seem to bring the phenomenon into line with the interpretation recently given by Gradmann in the same journal (*Die Naturwissenschaften*, April 15, 1927) of the movements of tendrils and the growth curvatures of twining stems. They do not carry us much farther forward until an interpretation is forthcoming of the internal mechanism of geotropic response.

CHROMOSOME LINKAGE IN ŒNOTHERA.—A significant paper dealing with the chromosome linkages which occur in many Œnotheras during diakinesis and the heterotypic mitosis, has been published by Miss F. M. L. Sheffield (*Annals of Botany*, vol. 41, p. 779). A very critical cytological study of several species and mutations shows a characteristic arrangement of the 14 chromosomes, except in one species in which the arrangement was variable. In two small-flowered species, *Œ. novæ-scotiæ* and *Œ. eriensis*, recently described from Canada, there is a closed ring of 14

chromosomes in diakinesis, followed by a regular zigzag arrangement on the spindle, thus determining the normal segregation of only two gametic types in pollen formation. *Œ. ammophila* has one free pair of chromosomes and a ring of 12, while the mutation *Œ. rubricalyx* has four free pairs and a ring of 6. Only rarely do departures from these arrangements occur in a plant. The bearing of these important results on the further analysis of mutations in Œnothera is obvious. It also appears that the linkage of chromosomes will account for the large amount of linkage of characters which occurs in Œnothera hybrids. Various schemes of chromosomes interchange and non-disjunction are worked out, in their bearing on the origin of mutations and other complicated problems in this group of plants.

FRUIT CANNING IN THE HOME.—Fruit canning as a home industry is at present almost unknown in England, one of the chief reasons being the difficulty for an unskilled operator to secure a satisfactory seal by soldering the 'hole and cap' can. However, a new hand sealing machine, for use with the open-ended or 'sanitary' can, has been introduced and thoroughly tested at the Campden Research Station. Full details for working this apparatus, with illustrations, are given in the Ministry of Agriculture's leaflet, No. 331. Although success depends chiefly on efficient sterilisation, the best results can only be obtained if the fruit for preserving is carefully selected for soundness and uniformity in ripeness. To avoid bleaching in the case of coloured fruit, cans coated with an acid-resisting lacquer can be obtained. Water gives quite satisfactory results as a covering liquid, but a sugar solution is better. The syrup, which must be used boiling, is poured over the fruit and the can sealed immediately, before cooling takes place, to ensure the exclusion of air. The cans are then boiled in water for sufficient time to destroy the enzymes and micro-organisms on the fruit, and finally cooled rapidly in running water to prevent over-cooking. The leaflet concludes with details of the best procedure to be followed in canning most of the common English fruits, as tested at the Research Station, together with a table indicating the best strength of syrup to use, and the time required in the boiling water to effect sterilisation in each case.

FORESTRY IN BRITISH HONDURAS.—The annual report for the year ending Mar. 31, 1927, the fifth year of the Department's existence, has been recently issued. The final Forest Ordinance (Ord. No. 32 of 1926) became law on Oct. 14, 1926. Rules under the Ordinance were sanctioned in December and came into force on Jan. 1, 1927, thus providing for adequate protection of the forests and a stable system of forest finance. Under this Ordinance the contribution to forest trust funds from general revenue during the financial year amounted to 50 per cent. of the total general forest revenue, the balance required being met from the Forest Loan Department. A satisfactory feature of the organisation and management of the new Department is the close co-operation of the latter with the timber exploitation companies. Substantial progress, it is said, has been made during the year in many aspects of the sylviculture of mahogany which will have, it is hoped, an appreciable effect in accelerating the establishment of a normal distribution of age classes over the areas in which improvements are being carried out. Arrangements are being made by the Chicle Development Company for intensive research to be carried out on their sapodilla estates in connexion with latex production and economic tapping methods. This important work in conjunction with the reafforestation of sapodilla, the investigations on the increment of *Achras sapota*, and the examination of the possible utilisation of inferior grades of chicle gums from allied species, will have far-reaching effects on the reconstruction of the industry. When it is remembered that the *Ficus elastica* was practically exterminated in the forests in the east of India by the seventies of last century through ruthless tapping, the steps being taken in the case of the sapodilla form a striking example of the manner in which public opinion is now commencing to envisage such matters. Exploration is being commenced in the western highlands between Vaca and the Rio Grande. It is anticipated that the information concerning this little-known locality will be considerably augmented during the trigonometrical work to be carried out by the Survey Department in connexion with the demarcation of the western frontier.

IRRIGATION IN INDIA.—The irrigated area in British India, according to the report for 1925–26 ("Government of India: Department of Industries and Labour (Public Works Branch). Irrigation in India: Review for 1925–26." Pp. 10 + 37. Simla: Government of India Press), was 28·1 million acres, or nearly a million acres more than in the previous year. The area is 12·9 per cent. of the total area cropped. In the Punjab the irrigation area was greatest; next came, in order, Madras, Sind, and the United Provinces. Among many projects now in progress to extend irrigation, the following are important: The Cauvery Metur project to bring another 300,000 acres under irrigation; the Lloyd dam at Bhatgar in the Nira valley, and the Lloyd barrage at Sukkur on the Indus. The monsoon in India during the year under review was on the average 4 per cent. below normal. It was characterised by strength in northern India until the middle of August, when it retreated abnormally early. In the Deccan it was weak throughout the season. The report contains statistical, including financial, details of the irrigation works in use.

PERCOLATION IN A SANDY SEASHORE.—The form of the surface of separation, under the ground near a sandy seashore, between the salt water which has diffused landwards from the sea, and the fresh water from the rain falling on the land, is investigated by T. Nomitsu, Y. Toyohara, and R. Kamimoto in No. 7, vol. 10 (Sept. 1927), of the *Memoirs of the College of Science, Kyoto Imperial University*. Herzberg, who had previously considered the problem, assumed that the fresh water was in statical equilibrium, floating on the sea water. The present writers take into account the seaward flow of the fresh water, and also the diffusion of salt into the fresh water underground. An approximate theory indicates that, as in Herzberg's theory, the surface of separation will be parabolic, but in the present theory the form of the parabola depends on the rate of flow of fresh water seawards, and on a certain constant of the soil. Diffusion of salt into fresh water is found to be relatively unimportant. Experiments on models confirmed the approximate theory.

COLLOIDAL SOLUTIONS AND ORE DEPOSITION.—In recent years Dr. H. C. Boydell has suggested several important applications of the principles of physical chemistry to problems of ore deposition. He has now contributed to the Institution of Mining and Metallurgy a long and masterly presentation of the subject as he sees it. In his absence, the paper was read at the October meeting by Dr. R. H. Rastall; it is published in the October *Bulletin* of the Institution. The chief topics dealt with are the processes involved in the precipitation of solids from molecular

and colloidal solutions. The abilities of colloidal solutions to account for many puzzling phenomena are summarised, and their many advantages over true solutions are convincingly recorded. Dr. Boydell insists, however, that he does not advocate colloidal influences to the exclusion of the agency of true solutions. The discussion that followed appears in the November *Bulletin*. Notable contributions, constructive and helpful in their criticism, were made by Prof. J. W. Gregory and Prof. J. C. Philip.

THE JAPANESE EARTHQUAKE OF MAR. 7, 1927.—Since the great earthquake of 1923, Japan has been visited by two destructive earthquakes, the Tazima earthquake of May 23, 1925, and the Tango earthquake of Mar. 7, 1927. The epicentres, which were only 11 miles apart, both lie near the north coast of the main island and to the west of Wakasa Bay. Of the two, the later earthquake was much the stronger. It resulted, as we learn from a brief but very interesting report by Messrs. A. Imamura and N. Nasu, in the loss of 2908 lives (*Proc. Imp. Acad. Tokyo*, vol. 3, pp. 227-231; 1927). Of the houses in the four central counties, 47 per cent. collapsed and 14 per cent. were burned. Fault-displacements occurred along two old and independent faults. The Gô-mura fault, to the north, is 11 miles long, and runs N.N.W. and S.S.E., the west side being uplifted so much as 2 feet and shifted towards the south by nearly 9 feet. A short distance to the south of this fault is the Yamada fault, a little more than 4 miles long and running in a direction at right angles to the other. Along this fault the north side has a maximum uplift of 16 inches and an easterly shift of 2½ feet. A permanent upheaval of about 2½ feet occurred along the Japan Sea coast from the Gô-mura fault westward for about 10 or 12 miles. Soon after the earthquake, seismographs were erected at three stations near the epicentre. The after-shocks recorded belonged to two classes. Those originating near the Yamada fault were of shallow origin, the foci in no case being more than 5 miles deep, while the others, belonging to the Gô-mura fault, originated in foci that were sometimes 12½ miles in depth.

TERRESTRIAL MAGNETISM AT SAMOA.—The Apia Observatory, Samoa, was founded in 1902 by the Göttingen Academy, originally for three years, and later as a permanent institution. When Samoa was occupied by New Zealand troops in 1914, the observatory was taken over by the N.Z. Government; the German director, Dr. G. Angenheister, with a staff of assistants, remained in charge until 1920, when arrangements for the further maintenance of the observatory were concluded between the N.Z. Government, the British Admiralty, and the Carnegie Institution of Washington. Dr. Angenheister was succeeded by Mr. C. J. Westland as acting director, and afterwards by the present director, Dr. Andrew Thomson. The reports of the observatory under the new regime have been issued for the years 1921 to 1923 (the last appearing in 1926), giving hourly values of the magnetic elements, and summaries of the observations on meteorology, seismology, and atmospheric electricity. Under arrangements with the New Zealand Government, Dr. Angenheister took with him on his return to Germany the observations taken under his direction, in order that he might reduce and discuss them. A summary of these data for the years 1912–1920, so far as they relate to terrestrial magnetism, has recently been issued, under the editorship of Prof. D. M. Y. Sommerville, of Wellington College, N.Z. It is to be hoped that this valuable summary will later be supplemented by the publication of the actual hourly values. The observations at Samoa are of particular importance, owing to the extreme paucity of magnetic observatories in the southern hemisphere, and to the great distance of Apia from the next nearest observatory. The value of the data is naturally enhanced by the now considerable period over which observations have been made there.

RUBBER SULPHUR COMPOUNDS.—Paper No. 560, by Curtis, McPherson, and Scott, published by the U.S. Bureau of Standards, gives the density and electrical properties of the compounds of rubber and sulphur for the range of composition from 0 to 32 per cent. of sulphur, that is, from crude rubber to hard rubber. Important changes in the properties with the proportion of sulphur are noted. These changes show definite regularities and occur at compositions which may be represented by simple empirical formulæ. The authors conclude that this indicates the existence of definite compounds of rubber and sulphur. When the composition contains 19 per cent. of sulphur, all the properties that were studied undergo significant changes. At this composition the slope of the curve connecting density with percentage of sulphur changes; so also does the curve showing the thermal expansion to percentage of sulphur. Both the specific inductive capacity and the power factor curves pass through minimum values at 19 per cent. of sulphur, while the resistivity curve bends upwards. The specific inductive capacity has a very decided maximum value when the composition is 10·5 per cent. of sulphur. The power factor shows a maximum at 13·5 per cent., whilst the resistivity does not attain its maximum value until the percentage is 26. Experiment showed that the effect of free sulphur on the electrical properties was small compared with the effect of the combined sulphur. Electric strength measurements are not recorded, because it was found that they seemed to be affected more by the conditions of the test than by the properties of the compound.

THE ATTENUATION OF RADIO WAVES OVER LAND.—Mr. R. H. Barfield read an important paper on Dec. 7 at the Institution of Electrical Engineers on the attenuation of radio waves when passing over land. The intensity of the London broadcasting station (2LO; $\lambda = 364$ m.) was measured in seven different radial directions, up to distances of about 100 miles. The over-all attenuation coefficient was then found from the experimental results and compared with results obtained by Sommerfeld's theory. The numbers found experimentally were much greater than the theoretical numbers. It is suggested that this discrepancy can be explained by the well-wooded nature of the English countryside. The energy-absorbing property of individual English trees was measured experimentally, and calculations are made for given densities of tree distribution founded on these results. It is concluded that the greater part of the discrepancy between theory and experiment can be ascribed to the trees. The experimental results show no evidence of screening or other effects produced by hills. The directions investigated included routes over the North and South Downs and the Chiltern and Cotswold ranges. It is proved that about 1600 trees per square kilometre will have an attenuating effect equal to that of the earth in the given experiments. In particular, actual counts in the districts north of London give 500 trees per square kilometre, and in the districts south of London about 4000 trees per square kilometre. Calculations based on the latter number give the observed value to the attenuation coefficient, but the agreement with the north of London routes is not good. Probably hedges and other vegetation, houses and other erections, contribute to the absorption produced.

The Hungarian Biological Research Institute.

By Dr. F. A. BATHER, F.R.S.

ON Sept. 5 the Regent of Hungary, Admiral Horthy, inaugurated the new buildings of the Hungarian institute for biological research at Tihany on the shores of Lake Balaton (Fig. 1). This institute has been founded through the exertions of the Minister for Education, Count Kuno von Klebelsberg, in pursuance of the general policy of the Government to restore the various cultural institutions of Hungary to the same high level as they occupied before the War, and where possible to raise the standard. It is gratifying to note the importance which His Excellence has attached to the development of the natural sciences. During his term of office one new university has been founded, and two rendered homeless as a consequence of the War have been re-established in fresh situations. Among the new developments may be mentioned the excellent modern equipment of the medical faculty at Debrecen, but the support accorded to pure biological research through this institute at Tihany is a still more manifest sign of this enlightened policy.

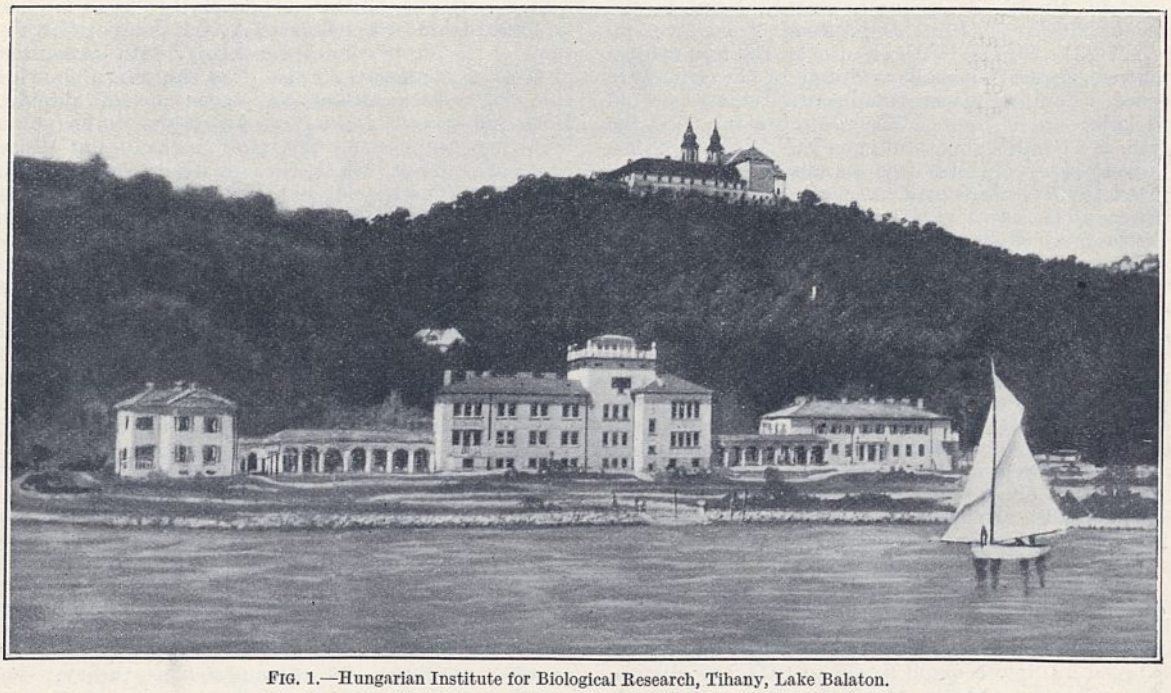

FIG. 1.—Hungarian Institute for Biological Research, Tihany, Lake Balaton.

The present institute was founded in 1926 in continuation and development of the Biological Station which was maintained at Révfülöp by the Hungarian National Museum. Work will continue in co-operation with other laboratories in Hungary, but the new situation and the admirable arrangements will greatly facilitate research.

Lake Balaton is the largest piece of fresh water in the south of Europe. With a length of 51 miles, it varies in width from two to nine miles, and attains in places a depth of 425 feet. It is rich in fishes and other forms of life. While the southern shores are low and flat, those on the north are formed by picturesque hills sloping steeply to the water. These hills owe their existence to a capping of Pliocene basalt and other volcanic rocks, which have preserved from complete erosion the underlying softer rocks, of an age ranging from Miocene to Permian. This is particularly the case at Tihany, where Eocene rocks capped by basaltic tuff form a peninsula which stretches more than three-quarters of the way across the lake. On the summit of the cliff stands the Benedictine abbey, founded in 1054, and on the strip of shore at its foot, between a small hotel and a villa of the Archduke Joseph, is the site of the research institute, enlarged to about four acres by building out on the shallow sandy lake floor. This site will be occupied by four main blocks: the laboratory building, lodgings for visiting workers, residence of the staff, and an aquarium open to the public; only the first two are completed.

The laboratory building consists of basement, raised ground floor, first storey, and a tower which adds another storey, and a flat roof with a small room on it. The institute is organised in two departments. The first, which occupies the ground floor, and is immediately under Dr. Béla Hankó, administrative director of the Institute, is devoted to zoology, botany, and hydrobiology. It contains the reception room and the laboratory of the director, the library, a laboratory for the botanist, one for the bacteriologist, a microscopical laboratory with six tables, and a room for the laboratory assistants.

The second department, which is on the first floor, conducts physiological, physical, and chemical research, and is directed by Dr. F. Verzár of Debrecen. It contains the laboratory of the director of the physiological assistant and a laboratory for the official chemist, two laboratories for single research workers, a balance-room, and an assistants' room. There is also a large laboratory for demonstrations to twenty students.

The tower contains an optical room, a drawing and photographic room, with a dark room, and the cisterns for Balaton water and artificial sea-water.

On the roof will be placed meteorological instruments. In the basement are workshops, store-rooms, engine rooms, and mechanician's lodging, a cold aquarium, fish-breeding plant, and a room protected against tremors by special pillars, and thus permitting of the finest physical measurements and photographic work.

Each working-place has a double aquarium with flowing Balaton water and aeration, a supply of three kinds of electric current, of gas made in the institute from benzol, of compressed air and vacuum draught, and of drinking water, and a hot-water heating apparatus. Water is sucked from a point 200 metres out in the lake, through a pipe of eternite into three successive basins, where the sediments settle, and is then sent by a bronze centrifugal pump to the cisterns in the tower; these last are painted with innertol, and the water supply pipes in the building are of lead. The working aquaria are modified from the Naples model; three of them can receive artificial or actual sea-water, which is stored in a stone cistern.

The thermostats, kymograph, nephelometer, and colorimeter, lighting, photographic, and all other apparatus are of the very latest and best design in whatever country that could be found.

The lodgings in the adjoining block provide twenty-six beds, in fifteen rooms; these are at present partly occupied by the staff. There are also a dining-room, servants' bedrooms, and the usual offices.

The programme of the Institute is, first, the biological investigation of Lake Balaton and other Hungarian waters; but it will undertake all kinds of research in general biology and physiology for which its resources are adapted. At certain times educational courses will be conducted, especially for teachers in secondary schools. It is particularly hoped that foreign workers will avail themselves of the facilities offered. Tables will be allotted to them according to the available room. A monthly fee of 125 penzö (about 14*s*. 4*d*.) covers a fitted working place, lodging, and research material up to 25 penzö (say 3*s*.). A place can only be retained so long as it is really used for work. His Excellence the Minister of Education expressed to me the wish that it might be possible to arrange for an exchange of similar facilities between Tihany and similar laboratories in the British Dominions at home or overseas; he would also be glad to see an exchange of publications. Should the publication of this appeal in NATURE meet the eyes of the very variously constituted bodies that govern such institutions within the British Commonwealth, they will doubtless respond to it in a friendly spirit. Those who wish to have complete sets of the *Annals* and other publications of the institute should not wait until the earlier numbers are out of print. Correspondence may be addressed to the Director, Dr. Hankó, Magyar Biológiai Kutato Intézet, Tihany, Balaton, Hungary.

The Undercooling of Some Aluminium Alloys.

ALTHOUGH the undercooling of pure metals was observed by Roberts-Austen so long ago as 1898, no experimental data have so far been published regarding the supersolubility curves of alloy systems, although explanations of certain structures have been based on their existence particularly in regard to eutectics. The recent May Lecture of Sir Henry Miers to the Institute of Metals on "The Growth of Crystals in Supersaturated Liquids" is now followed by a paper by Dr. Marie L. V. Gayler, delivered before the Institute of Metals on Sept. 7, on the effects of undercooling in some alloys of aluminium, in particular with silicon. The work was carried out for the Engineering Research Board at the National Physical Laboratory under the supervision of Dr. W. Rosenhain and breaks entirely new ground. For the first time the supersolubility curves for an alloy system are available, and with their aid an explanation of the structures of the aluminium-silicon alloys can be offered with a considerable degree of certainty.

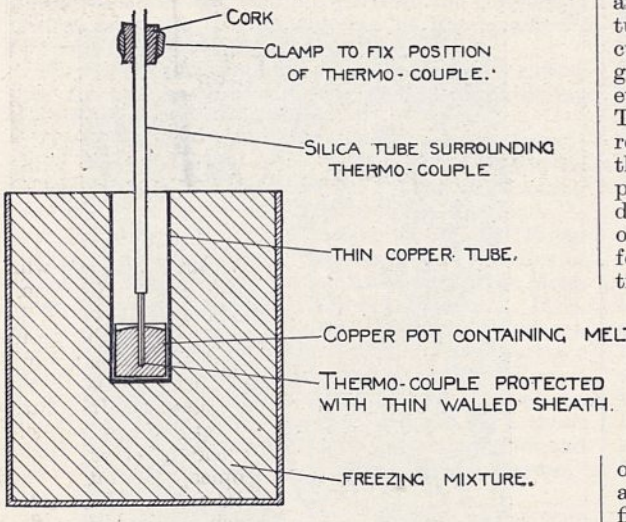

FIG. 1.—Diagram of apparatus.

The experimental method adopted consisted in melting the alloy in a thin copper pot, the wall thickness of which did not exceed $\frac{1}{64}$ in., raising the melt to a temperature of about 200° C. above the liquidus and then quickly dropping the pot into a copper tube immersed in a freezing mixture. A cooling curve was obtained on a Rosenhain plotting chronograph, readings being taken every 10° C. at first and every 5° C. after the first arrest had taken place. The general arrangement is shown in Fig. 1.[1] The results are represented by the dotted lines in Fig. 2, the continuous lines in the latter indicating the temperatures of the changes as normally accepted. The dotted lines indicated in Fig. 2 are thus representative of a definite rate of cooling, but there are good reasons for the belief that they approximate closely to the true supersolubility curves. In the first place, as will be shown later, they offer good grounds for the interpretation of the microstructure observed in the ingots, but far stronger reasons for this belief lie in the following facts.

As is well known, the aluminium-silicon alloys are normally more or less brittle. When, however, to the melt is added a small trace of sodium or other 'modifying' material, their mechanical properties and structures are radically effected. If the 'modification' is due to crystallisation along the supersolubility curves, it should follow that the freezing curves after modification should at any rate approximately coincide with the latter curves themselves. Secondly, the 'modification' should inhibit the attainment of a second series of supersolubility curves lying below those previously obtained. Miss Gayler has shown that both these results can be obtained. The freezing diagram obtained from the 'modified' alloys lies remarkably near to that of the supersolubility curves in Fig. 2, and systematic under-

[1] This and other illustrations are reproduced by courtesy of the Institute of Metals.

cooling does not occur in the ' modified ' alloys, supersolubility curves for which could, therefore, not be obtained.

The correlation of the foregoing curves with the microstructures is excellently effected. In Fig. 3, it

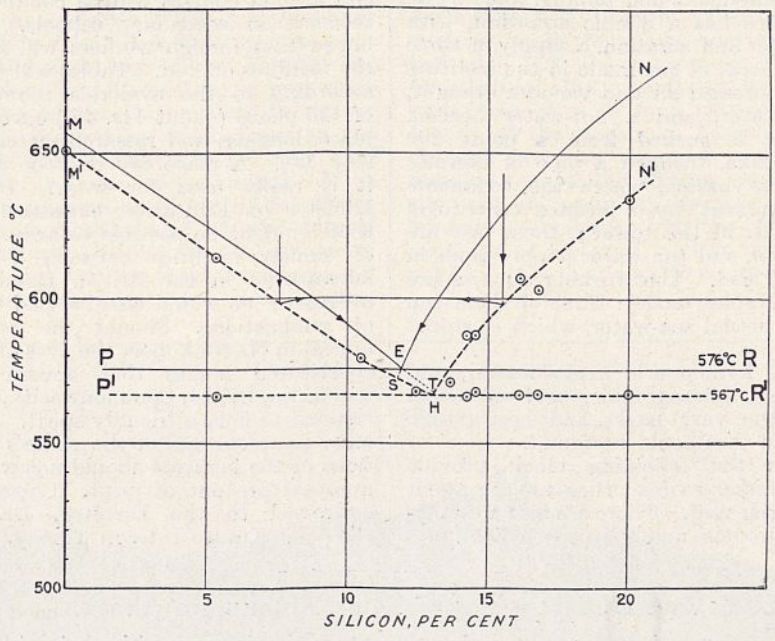

FIG. 2.

will be seen that besides the primary dendrites of aluminium, coarse silicon is present; this suggests that in this alloy, containing 10 per cent. of silicon, aluminium separates on cooling at a point on the supersolubility curve M'H in Fig. 2. The composition of the liquid then follows MET until the silicon supersolubility curve is reached at T, when silicon separates along TH until the hypertectic point H is reached and both constituents separate simultaneously. In the alloy containing 13·2 per cent. of silicon, the structure of which is shown in Figs. 4 and 5, however, silicon separates first at some point on the supersolubility curve N'H. The composition of the liquid then follows NS until S is reached, when aluminium separates spontaneously; the course of the liquid then probably oscillates between SH and TH until the point H is reached, when aluminium and silicon separate together. It will be seen in Fig. 5 that the primary silicon is surrounded by dendritic aluminium.

The structures of the ingots obtained are of much interest, and the results may not improbably throw considerable light on the general question of ingot crystallisation. Contrary to what would, perhaps, generally be expected, since the outside of the ingot must be the more rapidly cooled, the structure of the

FIG. 3.—10·0 per cent. silicon. Centre of ingot. ×150.

FIG. 4.—13·2 per cent. silicon. Edge of ingot. ×150.

outside rim to a depth of approximately $\frac{1}{16}$ in, is much coarser than that inside. The character of the crystals is also different, particularly that of the silicon,

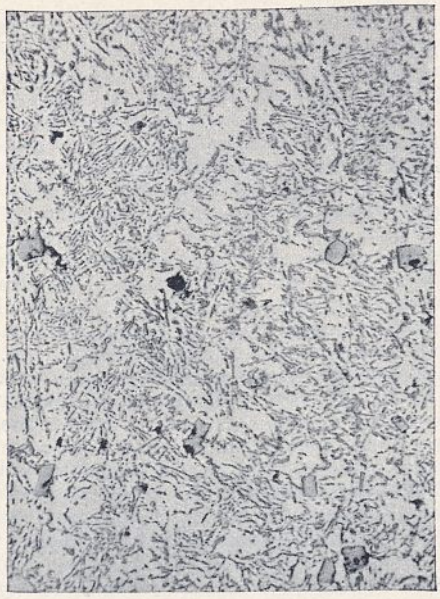

FIG. 5.—13·2 per cent. silicon. Centre of ingot. ×150.

which takes a definitely needle shape, while the silicon in the centre of the ingot is in more rounded particles and much finer needles. F. C. T.

University and Educational Intelligence.

LONDON.—The title of emeritus professor of pathology in the University has been conferred on Sir Frederick Andrewes, who retired from the University professorship of pathology tenable at St. Bartholomew's Hospital Medical College in July last.

The Senate has decided to make a grant of £200 a year for five years towards the cost of maintaining the British Institute in Paris.

The following doctorates have been conferred: D.Sc. in Chemistry—Miss P. V. M'Kie (Bedford College), for a thesis entitled "The Interaction between Nitric Acid and Unsaturated Compounds"; and Mr. A. W. Chapman (Imperial College (Royal College of Science)), for a thesis entitled "Studies of Isomeric Change—with special reference to the Molecular Rearrangement of Imino-aryl Ethers." D.Sc. in Zoology—Miss H. S. Pearson (University College), for a thesis entitled "On the Skulls of Early Tertiary Suidæ, together with an Account of the Otic Region in some other Primitive Artiodactyla." D.Sc. in Veterinary Pathology—Mr. F. C. Minett, for a thesis entitled "The Standardisation of Immune Serum and the Nature of Immunity in Foot and Mouth Disease," and other papers.

A free public lecture on "Recent Discoveries throwing New Light on some of the Commonest Insects" is to be given by Prof. E. B. Poulton, at Bedford College for Women, at 5.15 on Jan. 31.

WITH the view of encouraging original research in sanitary science, the Grocers' Company is offering scholarships of the annual value of £300 each, plus a further amount for expenses. The scholarships are tenable for one year, but renewable up to three years. A form of application can be obtained from the clerk of the Grocers' Company, Grocers' Hall, E.C.2.

THE Pan-American Union has issued in Washington, D.C., two pamphlets containing the projects of the International Commission of Jurists, "Public International Law" (pp. 40), and "Private International Law" (pp. 68). These drafts are the findings of sessions held at Rio de Janeiro in April and May 1927, and are to be submitted for the consideration of the sixth International Conference of American States which will convene at Havana, Cuba, in January 1928. Under Public International Law two of the earlier projects are (v.) Exchange of publications and (vi.) exchange of professors and students. The remuneration of the professor shall be paid by the institution which has appointed him, unless his services shall have been expressly requested, in which case his remuneration shall be borne by the institution which invited him. In Private International Law, Chap. ii. is on domicile: "The domicile of diplomatic officials and that of individuals temporarily residing abroad in the employment or commission of their government or for scientific or artistic studies, shall be the last that they had in their own territory."

THE annual meeting of the Science Masters' Association will be held on Jan. 4-6 at the Imperial College of Science, under the presidency of Sir Richard Gregory. Evening meetings will be held at King's College for Women, Campden Hill Road, Kensington, W.8, where the presidential address on "Contacts of Science and Literature" will be delivered on Jan. 4. The programme includes discussions on the need of scientific investigators for the agricultural industries overseas, to be opened by Sir J. B. Farmer and Capt. Irby (Colonial Office), and on industrial openings in scientific technology, to be opened by Prof. W. A. Bone, and lectures by Dr. J. W. T. Walsh on modern methods in photometry and by Prof. J. C. Philip on charcoal and its activation. Visits have been arranged to the London docks, the United Dairies, Ltd., the Lighting Service Bureau, the Gas, Light, and Coke Co., and to the new laboratories at Highgate School. During the meeting there will be exhibits by members of the Association and by instrument makers and related firms, and also a display of books by leading publishers. Correspondence should be addressed to the organising secretary, Mr. I. M. Bankes-Williams, at the Chemistry Department, Imperial College of Science, South Kensington, S.W.7.

THE October number of the *University Bulletin*, issued by the Association of University Teachers, contains a report on the representation of teaching staffs upon university bodies. This is the outcome of the labours of a committee appointed to inquire into the subject. A sufficient warrant for undertaking such an inquiry is to be found in the University Grants Committee's report of 1925, in which attention was directed to the reasons why lecturers as well as professors should be accorded a more clearly recognised position in the government of the universities, and, in particular, why they should be represented on the executive governing bodies. Appended to the report of the Association's committee, which concludes by reaffirming the opinions of the University Grants Committee, is a useful tabular statement showing the actual position in the civic universities of England and the University of Wales. In the same number appears, under the title "Jottings from the University of Utopia," a summary of advanced views on adult education, vocational guidance, and "earning while learning." In an article on the "wider aspects of extra-mural work," emphasis is laid on the value to the civic universities of their adult education work as a means of keeping them in touch with public opinion in the regions they serve.

Calendar of Customs and Festivals.

January 1.

FEAST OF THE CIRCUMCISION.—New Year's Day, marked in the Christian Calendar as the Feast of the Circumcision, being the eighth day after the day fixed by the early Church as the birthday of Christ, which coincides with the great mid-winter festivals of paganism. The ceremony of circumcision, usually, though not invariably, a puberty or initiatory ceremony among races practising the rite, was performed by the Jews on the eighth day after birth. Circumcision was an essential condition of participation in the Passover and was enjoined on every male member of each household, including slaves, and on proselytes. In the case of the latter, however, it became later a subject of acute controversy. A widespread custom among modern peoples, especially in Africa, its origin and purpose are obscure. It was practised by the ancient Egyptians, but probably was not originally a Hebrew or even a Semitic rite, although the use of a stone to circumcise the son of Moses, as is usual when an obsolete instrument or material is used ceremonially, is an indication of high antiquity. The attribution of its practice to Abraham may be taken as a mythical explanation of its significance in Jewish ritual as a mark of the right of admission to or a condition of participation in the most important of Hebrew ceremonial observances.

NEW YEAR'S DAY.—Although the entry upon a New Year has not always and everywhere taken place upon Jan. 1, its proximity to the winter solstice, when the sun turns to an upward path, made this a peculiarly acceptable date to peoples of the northern hemisphere, where there is a marked difference between winter and summer. Among other seasons which have served for the beginning of a new annual period are early spring or late autumn, at about the time of what is now All Souls, coinciding respectively with the awakening and the closing of the activity of vegetation—the turning points of the Celtic year—the rising of the Pleiades or the end of the harvest, while the ancient Egyptians, in theory, regulated their year by the heliacal rising of Sirius.

Whatever the period of the year adopted, the practice common to many peoples is to prepare for the new era as the old year draws to a close by a period of ceremonial purification which drives out evils and especially the spirits and ghosts of the dead, this being followed by a time of rejoicing, just as in the English Church the peal of bells welcomes the New Year after the solemn vigil of the Watch Night. In the Andamans at the end of the monsoon, the spirits which haunt the village are collected in leaves which are thrown into the sea. The pagan tribes of Borneo send the spirits of evil floating away in little boats.

In Great Britain there are still traces of this desire to be rid of the influences of the past. Sometimes old clothes are burned on New Year's Eve. New clothes, or at least some one piece of new clothing, must be worn or no good luck will follow. A significant custom of the Strathdown Highlander in Scotland enjoined the drinking of water from the "dead and living ford," an aspersion, and a fire of juniper branches gathered for the purpose on New Year's Eve and put to dry all night, which made a stifling smoke in all the house, as a necessary preparation for the rejoicings of New Year's Day. Horses and cattle were also fumigated.

Many primitive peoples practise the ceremony of the scape-goat at the New Year, the sins and ills of the community being borne away by the animal, goat or other, when it is driven out. Possibly the same idea lies far behind the custom once followed in Cumberland and Westmoreland of riding on the 'stang,' a piece of timber, all who refused to contribute to the merrymaking expenses of the party 'carrying the stang.'

Most modern New Year's customs, while involving the element of merrymaking, in their relation to belief—religious in a broad anthropological sense—are originally connected with omens, forecasting fortune in the coming year, the omen becoming, as often, by intentional performance an ensurance of good luck. A man, not a woman, and dark and not fair, should be the first to cross the threshold on New Year's morning. Something should be brought into the house, even if only a piece of coal, before anything is taken out; some new garment should be worn. Hence the custom of 'first footing'—the house-to-house visits after twelve o'clock of parties headed by a dark man bearing food and drink, thus ensuring prosperity to the house during the coming year. The custom of New Year gifts, now more common perhaps on the Continent than in England, goes back to the Romans and beyond—a custom in which the early Christians were forbidden to join. The ceremonial cutting and distribution of the mistletoe by the Druids in the New Year, a practice now transferred to Christmas, was intended to ensure the same prosperity among the worshippers throughout the year.

January 6.

EPIPHANY. TWELFTH NIGHT. OLD CHRISTMAS DAY.—Twelfth Night marks the end of the celebration of the Christmas or winter festival, though there is evidence for a period of twenty days which was sometimes prolonged until Candlemas. It is especially associated with honour to the Three Magi or kings who brought gifts to our Lord, in memory of whom royalty used to make offerings of gold, frankincense, or myrrh on this day.

The customs of Twelfth Night fall into at least three groups. The best known were connected with the feast, with a regular ceremonial, which for long was observed by all from royalty downward in England, France, Germany, and other countries, though when celebrated by Mary Queen of Scots it was recorded as a French custom. This ceremonial included the election of a king, known as the 'King of the Bean,' and sometimes a queen, and a ceremonial cutting of the Twelfth Night cake, in which was included a bean or coin, allotting the office of king, and sometimes other gifts, foretelling varying fortune for those who obtained them. In Herefordshire a holed cake was made which was placed on the horn of an ox in the stable, and according as he tossed it in the direction of the bailiff or the mistress, it became the perquisite of either.

The election of a king or 'Lord of Misrule' points to that frequent subversion of law and order in certain types of festival such as the Saturnalia and the Carnival, which derives from the primitive abandonment of all social regulation and the prevalence of complete sexual licence at certain stated seasons for the magical promotion of fertility in Nature. In the west of England it was the custom to light fires in the fields or on the hill tops. In Gloucestershire thirteen fires represented our Lord and the twelve apostles, and in Brough in Westmoreland holly bushes with torches attached were carried round the town. These customs are comparable with the ceremonial bonfires at midsummer and other times of the year.

A fertility ceremonial is also recorded. In Cornwall, Devon, and Herefordshire, it was the custom to visit the orchard, and after firing a gun, which would drive away the spirits of evil, to pour a libation of cider over the apple trees, while a verse—a charm to secure a good crop—was recited.

Societies and Academies.

LONDON.

Linnean Society, Dec. 1.—A. T. **Hopwood**: Exhibition of vertebrate remains from the Miocene of Kenya Colony. These specimens are the first mammals from beds older than the very top of the Pliocene recorded from the eastern half of Central Africa. The collection contains three genera of creodonts, two of artiodactyls, and three or four of rodents containing some seven or eight species. The rodents are closely allied to those living in the region at the present day.

Society of Public Analysts, Dec. 7.—Harold **Toms**: Oil bromine films and their use in determining the halogen absorption of oils. Oil films exposed to an atmosphere of bromine absorb the halogen quantitatively, and, after removal of the excess of bromine at a low temperature, the bromine absorption can be determined gravimetrically. The method, which gives accurate results with 20-50 mgm. of an oil, has been used to determine the composition of the insoluble bromide of linseed oil, after removal of the bromine, by prolonged treatment with nascent hydrogen. The iodine values, calculated from the bromine absorbed, agree with those obtained by the Wijs method, except in the case of tung oil, the gravimetric bromine absorption of which stands in a constant relationship to the iodine value.—G. **Middleton** and F. C. **Hymas**: Tests for impurities in ether. (1) Tests for peroxides. Only organic peroxide (probably dihydroxydiethyl peroxide) is to be expected in ether purified for anæsthesia. The ferrous thiocyanate test is recommended for official adoption, and a colorimetric limit for the amount of peroxide is proposed. This test gives no coloration with pure ether, and is not too stringent for practical purposes.—H. J. **Stern**: Arsenic in coated papers and boards. Mineral pigments are usually satisfactory, but some of the synthetic inorganic pigments may be dangerous. Thus, a paper coated with an arsenical green may contain more than 6 gm. of arsenious oxide per square metre. Some of the lakes of synthetic dyes, notably magenta and methyl violet, precipitated with arsenious oxide, contain dangerous amounts of arsenic (*e.g.* 40·5 per cent. of As_2O_3). Certain dyes, notably Pigment Scarlet 3B and Orange II, may contain 50 to 100 parts of arsenic per million. A provisional arrangement is in force limiting the amount of arsenic to 10 parts per million, and the boards in use seldom contain more than 2 or 3 parts per million.

CAMBRIDGE.

Philosophical Society, Nov. 21.—D. R. **Hartree**: The wave mechanics for an atom with a non-Coulomb central field. The methods developed can be applied to find the self-consistent field of an atom, that is, a field such that the solutions of the wave equation for that field which corresponds to core electrons give a distribution of charge which reproduces the field. Approximations to the self-consistent fields for He, Rb^+, Na^+, Cl^- have been worked out; for the normal state of He the characteristic value of the wave equation for the self-consistent field gives an ionisation potential of 24·85 volts (obs. 24·6 volts); the most extensive work is for Rb, for which the general agreement between calculated characteristic values and observed terms of optical and X-ray spectra is satisfactory.—W. H. **McCrea**: The specific heat of hydrogen at high temperatures. The specific heat of hydrogen calculated from the empirical energy levels found by T. Hori from the H_2 band spectrum is in good agreement with experiment, especially for temperatures in the neighbourhood of 2000° abs. Similar calculations for oxygen, nitrogen, and carbon monoxide do not give agreement with observed values.—S. L. **Malurkar**: On the arc spectrum of antimony. The arc spectrum of antimony has been arranged as due to the combination of about thirty levels which are denoted by $3d_2d_1$, $1s$, $3D_2D_1$ and Greek letters by Ruark-Mohler, Foote, and Chenault. It was possible to fix approximately the nature of these levels after the Hund-Heissenberg theory of complicated spectra. A note is added on the arc spectrum of arsenic.

DUBLIN.

Royal Dublin Society, Nov. 22.—E. B. **Forbes**: Comment on a paper by James Wilson on "The maintenance requirements of cattle on different rations and at different rates of production; with a note on 'dynamic action.'"—J. **Wilson**: The maintenance requirements of cattle. A reply to E. B. Forbes's criticism.—D. T. **Barry** and J. **Freud**: Some experiments on feeding rats with soya bean and other materials. Feeding white rats on soya bean and its products causes some diarrhœa, but no avitaminosis is noted as compared with meat. On white flour alone, avitaminosis was evident and also protein deficiency in one case by the animal eating its tail. This was corrected by meat. Soya products are good supplementary foodstuffs.—E. T. S. **Walton**: The formation of vortices behind a cylinder moving through a fluid. A large number of photographs have been taken of the vortex trains behind different cylindrical rods moving through water at various constant velocities, the drag on the rod being also recorded in each case. The experiments were undertaken to test Kármán's formula for resistance $R = \rho\kappa h/\tau$ and the modified formula of Synge, involving an additional term. The velocity of the vortices was found to be $u = 0{\cdot}146U$, which is about one-third of the value obtained on Kármán's assumption $\kappa = Ul$. For large Reynolds's number the resistance was found to agree approximately with Kármán's formula, when the values obtained by experiment were substituted on both sides of the equation. The additional term in Synge's formula was less than the experimental error. Graphs are given connecting the dimensionless quantities $D/U\tau$, u/U, $R/\rho D U^2$, κ/lU with the Reynolds's number.—J. Bayley **Butler** and J. J. C. **Buckley**: *Catenaria anguillulæ* as a parasite of the ova of *Fasciola hepatica*. The infection arose in some ova of the fluke that had been kept in the laboratory nearly nine months, and is believed to have been introduced through changing the water in the test-tubes. The cultures are readily grown on living and dead ova, and a large percentage of eggs exposed to infection become infected within a week. The development of the zoospore, the formation of sporangia and the re-infection of other eggs by zoospores, were described.

LEEDS.

Philosophical and Literary Society, Nov. 15.—W. F. **Beard**: On the occurrence of a determinantal system of points of the fourth order.—F. A. **Long**: An electromagnet giving large fields. An electromagnet is described which gives considerable fields in a wide gap with small power consumption. It includes an oil-cooling and insulating system and a device to prevent a large E.M.F. developing on breaking or changing the current.—D. **Brown**: Further experiments on electron reflection. An account of an investigation into the energy of low-speed electrons after striking hot and cold oxide surfaces. The results suggest that whereas a hot oxide surface

behaves like an ordinary good conductor, the cold surface, by reason of its semi-insulating character, becomes electrically charged, thus influencing the energy of the reflected electrons.—E. W. Smith: The oxidation of branched chain aliphatic acids. The results indicate an increasing ease of oxidation in the series isobutyric, isovaleric, isocaproic, isoheptylic acids. These qualitative experiments were carried out chiefly to explore the suitability of this series of acids for definite measurements of their initial velocity of oxidation.—H. M. Dawson: The co-ordination of the catalytic effects produced by an acid in different reactions and a modified form of the generalised catalytic equation. An alternative form of the general equation which co-ordinates the catalytic effects of hydrogen ion and acid has been derived. The ratio of the quantities of salt which are required to reduce the reaction velocities of two different reactions to their respective minimum values depends on the square root of the ratio k_h/k_a. For a given catalysing acid this salt ratio is independent of the concentration of the acid.—J. H. Priestley and Dorothy Tong: The effect of gravity upon cambial activity in trees. Gravity modifies the activity of the cambium in horizontal woody stems. In the Dicotyledon it increases wood formation and retards lignification on the upper side of the stem and decreases wood formation and accelerates lignification on the lower side. There are numerous exceptions to this rule in Nature. In the Gymnosperm the effect of gravity is to produce more wood with thicker walls and greater lignification on the lower side. There are very few exceptions to this rule. That in all cases lignification and the thickening of the wall proceeds more quickly on the lower side of the branch, explains the fact that on this side the wood elements are shorter and therefore better able to resist compression, while the longer elements on the upper side resist tension better. The different behaviour of Dicotyledons and Gymnosperms is correlated with other differences in cambial activity in these two groups.

PARIS.

Academy of Sciences, Nov. 28.—V. Grignard and G. Mingasson: The reduction of acid chlorides under reduced pressure: method of preparation of aldehydes. With nickel or nickel chloride as catalyst, at a temperature of 225° C. hydrogen at a pressure of 140 mm. reduces benzoyl chloride to benzaldehyde, with a yield of 60 per cent. At 200° C., with hydrogen under 400 mm., phenylacetyl chloride gives a 50 per cent. yield of the aldehyde. The chlorides of fatty acids under similar conditions also give aldehydes, but the yields are poor, probably owing to the higher vapour pressures of the aldehydes produced.—Alexandre Pantazi: The projective applicability of developable surfaces.—Paul Mentré: The flecnodal complex of a ruled surface.—J. A. Lappo-Danilevski: General algorithmic solution of the regular problem of Riemann.—Nicolas Mouskhelichvili: The approximate integration of the biharmonic equation.—Basile Demtchenko: Disturbing forces acting on a body which moves in a liquid near a wall.—A. Lévèque: The theoretical solution of the problem of heat exchange by the circulation of a viscous fluid in steady motion inside a cylindrical tube.—René Darbord: New method for the absolute measurement, at high frequencies, of the dielectric constants of liquids. A special form is given to the condenser and the result is unaffected by the dispersion of the lines of force.—L. Cagniard: The variation of the dielectric capacity of fluids in intense electric fields. The apparent diminution of the dielectric constant is due to a parasitic phenomenon which it is not possible to eliminate completely, and proves nothing for or against the existence of dipoles.—C. Gutton and Mme. J. Mihul: The permeability of iron at high frequencies.—A. Piccard and E. Stahel: The absence of the ether wind at the Rigi. The experiments of Miller were not confirmed.—C. Eichner: The decomposition of the vanadyl sulphates at high temperatures.—Marcel Godchot and Mlle. Cauquil: Some derivatives of the *cyclo*-octane series. The preparation and properties of a new alcohol, *cyclo*-octanol, are given.—F. Hermann: New conceptions on the tectonic of the Franco-Italian Alps.—René Souèges: The embryogeny of the Leguminosæ: the last stages of the development of the embryo in *Medicago Lupulina*.—L. Blaringhem: The heredity of sex in hybrids of pinks, and especially in *Dianthus barbatus* × *D. caryophyllus*.—L. Lavauden: Some effects of the dry climate on the higher vertebrates of northern Africa. Study of the changes produced by several very dry seasons: the most marked result was the cessation of reproduction both in mammals and birds.—Th. Cahn and A. Bonot: The demonstration of the existence of reserve proteids in the liver of mammals.—K. M. Bykow and Alexeiew Berkman: The creation of reflexes conditional on diuresis.—Philippe Fabre: Distinction between measurements of excitability and measurements of neuromuscular velocity of excitability: a new test of excitability.—G. M. Frank and S. J. Salkind: The mitogenetic radiation of the eggs of the sea-urchin. The mitogenetic emission of impregnated eggs takes place only during the second hour: it precedes the cell division. This is in agreement with the hypothesis of Gurwitsch.—Mlle. L. Dehorne: A ciliated parasite of *Clitello arenarius*. Its relations with *Opalina* (*Anoplophyra*) *filum* of Claparède.—G. Guittonneau, Mme. J. François Perey, and Mlle. M. Béjambes: The protozoa of the soils of Agenais.—J. Legendre: Races of *Stegomya fasciata* and yellow fever.—Selman A. Waksman and René J. Dubos: The nature of the organisms which decompose cellulose in arable soils.

GENEVA.

Society of Physics and Natural History, Oct. 20.—Fernand Chodat: Results of an atmometric inquiry at the "La Linnæa" alpine garden. The author communicates results of the application of atmometric methods to plant ecology. The experiments clearly show that with a new quantitative index, the atmometric index (numerical value of the evaporation of the place studied), it is possible to complete the ecological description of a plant station.—Raoul Pictet: Experimental demonstration of the potential of the ether. Its consequences in the physical theory of the properties of vapours and gases. In support of his theory on the reality of the ether, the author indicates an experimental scheme which would tend to confirm the results described in a previous note.—Arthur Schidlof: The interpretation of the masses of the electron and the proton in the universe of five dimensions. Keeping all the other premises of the theory of the five-dimension universe of O. Klein, but relinquishing the supposition that the Einstein element of space-time ds is an invariant, a unique equation is obtained for the electron and proton which allows an interpretation of the fact that the change of sign of the electric charge gives as a consequence a value of the true mass of the proton 1840 times as great as that of the electron.

ROME.

Royal National Academy of the Lincei: Communications received during the vacation.—U. Cisotti: The divergence of tensors.—G. Abetti: Observations of the partial solar eclipse of June 29, 1927, carried out at

Arcetri.—A. **Angeli**: The biochemical transformation of tyrosine into pyrrole derivatives. Tyrosine is convertible into pyrrole derivatives by the action of oxidising enzymes and into 5 : 6-dihydroxyindole by means of tyrosinase, and Bloch suggests that the melanins are formed from hydroxytyrosine under the influence of a special enzyme, termed dopa-oxydase. Since, however, hydroxytyrosine has not yet been detected in the animal organism, and extracts of melanotic tumours do not colour tyrosine, although they readily blacken with pyrrole, it seems probable that, in such cases, the formation of melanin is due to the less complicated oxidation of products containing ready-formed pyrrole nuclei in their molecules.—G. **Lampariello**: The theorem of the derivation by series.—B. **Colombo**: The transformations (m, n) between $m+n+4$ integrals of two equations to the partial derivatives of the second order in two independent variables.—A. **Colacevich**: Estimates of the magnitude of the Pons-Winnecke comet. Naked-eye, binocular, and equatorial observations of this comet made in June give for its magnitude values varying from 4·7 to 9·3. The nucleus appeared to be stellar, especially during the period June 20-26. Indications of a tail were discernible by means of the equatorial, its length from the nucleus being 8′. The head appeared as a circular nebulosity of radius 4′.—L. **Fernandes**: Complexes of uranyl with polyphenolic acids. Addition of orthoxynaphtholic acid to a solution of uranyl acetate results in a red coloration, which becomes accentuated as alkaline carbonate is added. If this addition is arrested when the solution is neutral or faintly alkaline, a complex derived from the acid $[UO_2(C_{10}H_8O \cdot CO_2)_2]H_2$ is obtained. If, however, the solution is faintly acid and the uranyl salt is in considerable excess, a yellow, crystalline compound of the type $\left[UO_2{}^{(C_{10}H_8O \cdot CO_2)}_{OH}\right]H_2$ separates. Protocatechicouranates of the form $[UO_3(C_6H_3O_2 \cdot CO_2)]H_2$ are obtainable similarly.—C. **Antoniani**: The behaviour of arsenic acid with regard to the absorbent power of soil. Arsenic acid behaves similarly to phosphoric acid in relation to absorption by soil, although it is absorbed to a less degree. With reference to the possibility of the interchange of the phosphoric and arsenic anions, experiment shows that PO_4''' is replaced by AsO_4''' in solutions of arsenic acid, but not in those of arsenates.—G. **Quagliariello** and P. **De Lucia**: Stereoisomeric transformations of glucose by the action of insulin and of muscular tissue. The authors' experiments fail to furnish confirmation of Lundsgaard and Holboll's results, which indicated (1) the existence in the internal liquids of normal animals of an unstable form of glucose (neoglucose) having a very low rotatory power, and (2) the formation of this compound *in vitro* by the simultaneous action of insulin and fresh muscular tissue on *d*-glucose.—G. **Bergami**: Action of low temperatures on the crystalline lens. When subjected to low temperatures, the crystalline lens of the sheep or ox behaves like dialysed blood-serum, undergoing partial, reversible coagulation and becoming opaque in the central part. Ringer's hypertonic solution produces similar opacity, which disappears if the lens is immersed in Ringer's hypotonic solution; the action of the former solution probably consists in dehydration of the lenticular colloids. The simultaneous action of low temperature and of Ringer's hypertonic solution also results in opacity, reversible at room temperature, even in the crystalline lens of the dog, which is rendered opaque neither by cold nor by the hypertonic solution alone.—G. **Cotronei**: Affinities in Petromyzon according to morphological-systematic and ecological characters.—L. **Patanè**: The perintestinal layer of the meso-intestine of Balanus. The peculiar layer of cells, discovered by Monterosso in the meso-intestine of *Balanus perforatus* (Bruguière) and termed, first, the peritoneal layer, and later the perintestinal layer, occurs also in *Balanus porcatus*, *B. trigonus*, and *B. eburneus*. These cells always, or almost always, contain parasomes, and exhibit different morphological and structural peculiarities in the different species.—Pia **Nalli** and G. **Andreoli**: Green's formula in the complex field and the extension of Cauchy's theorem to functions of two complex variables.

SYDNEY.

Linnean Society of New South Wales, Oct. 26.—G. H. **Hardy**: Notes on Australian and exotic Sarcophagid flies. A detailed study of the male genitalia would enable the large genus Sarcophaga to be divided into groups of naturally allied species. This is done for some Australian and exotic forms, three groups being defined on this principle, namely, the *antilope*-group with six species, the *misera*-group with seventeen, and the *peregrina*-group with four. Two species from Java are described as new.—Miss H. Claire **Weekes**: Placentation and other phenomena in the scincid lizard, *Lygosoma* (*Hinulia*) *quoyi*. An allantoplacenta is described of a type hitherto not recorded for reptiles. The uterine and allantoic capillaries are exposed at the surface of the maternal and fœtal tissues respectively, and scattered cells of the chorionic ectoderm are superficially attached to the maternal wall. This type of placentation is fundamentally similar to that of the marsupial, Perameles.

Royal Society of New South Wales, Nov. 2.—A. R. **Penfold**: The essential oils of two species of Bæckea. *B. brevifolia* is a small leaved plant of about 18 inches in height which yields more than 1½ per cent. of essential oil consisting of α- and β-pinene, cineol, and eudesmol. *B. linifolia* is a tall shrub with drooping branches and white flowers, which yields 0·67 per cent. of essential oil containing α- and β-pinene, cymene, cineol (18 per cent.), sesquiterpenes, esters, etc.—M. B. **Welch**: The moisture content of some eucalyptus woods. Moisture determinations were made on four species of Eucalyptus growing near Sydney, namely, *E. eugenioides*, *E. piperita*, *E. micrantha*, and *E. Sieberiana*, at intervals over a period of some years. The variation in moisture content which occurs in individual trees, between heartwood and sapwood, and in the same species at different periods, appears to be due to physiological and ecological factors affecting the particular tree in question and cannot be correlated with season or rainfall.—G. S. **Currey**: The cause of blueing in roses. The effect is due to lack of tannin in the cell-sap. Some varieties show a greater tendency to blue than others; "Hadley" represents a blueing type, while "Lady Maureen Stewart" very seldom shows this defect. Both types contain the same anthocyanin pigment, namely, cyanin, which occurs in the petals as a glucoside; but the latter contains the larger quantity and there appears to be a direct relationship between the quantity of pigment and tannin present.

VIENNA.

Academy of Sciences, Oct. 13.—F. **Hölzl**: The alkylisation of molybdeno-hydrocyanic acid. Experiments with dimethyl sulphate and the potassium salt, and with methyl iodide and the silver salt.—E. **Gebauer-Fülnegg** and E. **Petertil**: The simultaneous determination of chlorine in the presence of sulphur in organic compounds.—E. **Gebauer-Fülnegg**: Sulphur containing derivatives of *p*-dichloro-

benzole.—P. Ludwick and R. Scheu: Brittleness and notch-tenacity.

Oct. 27.—F. W. Palm: Surfaces and curves of equal parallax in photographic surveys.—A. Haas: The connexion between the theory of relativity and theory of quanta.—A. Pongratz: Researches on perylene and its derivatives.—N. Kreidl: Communication of the Radium Institute, No. 210. Applicability of Geiger's point-counter to experiments on atomic disintegration.

Nov. 3.—V. H. Hess: Formation and annihilation of ions in the atmosphere above the sea and in the mountains. Schweidler's method, using a cylindrical condenser, has been improved and used to determine the vanishing constant of the light ions and its reciprocal, their mean duration of life.—R. Müller, V. Raschka, and M. Wittmann: Electrochemistry of non-aqueous solutions (8). Conductivity measurements in dilute solutions of silver nitrate, silver rhodanide, and silver bromide.—E. Gebauer-Fülnegg and E. Riesz: The oxidation process in aryl-sulphuranilides.—C. A. Bobies: The tertiary formations of the basin of Gaaden.

Official Publications Received.

BRITISH.

Scottish Marine Biological Association. Annual Report 1926-27. Pp. 23. (Millport: Marine Biological Station.)

Apia Observatory, Samoa. Summary of Magnetic Observations, 1912-20. Pp. 40. (Wellington, N.Z.: W. A. G. Skinner.)

Proceedings of the Royal Society of Edinburgh, Session 1926-1927. Vol. 47, Part 3, No. 23: On the Discharge of a Condenser through a Gas at Low Pressure. By W. G. Thomson. Pp. 302-306+1 plate. 9*d*. Vol. 47, Part 3, No. 24: The Grasp of Mind on Nature. By Sir Joseph Larmor. Pp. 307-325. 1*s*. 6*d*. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.)

The Imperial College of Tropical Agriculture. Prospectus for 1928-29, also Principal's Report for 1926-27, and Register. Pp. 34+2 plates. (St. Augustine, Trinidad, B.W.I.; London: 14 Trinity Square.)

Department of the Interior, Canada: Dominion Water Power and Reclamation Service. Water Resources Paper No. 60: Water Powers of Canada. Pp. 94. (Ottawa: F. A. Acland.)

New Zealand. Department of Lands and Survey: Scenery-Preservation. Report for the year ended 31st March 1927, together with Statement of Accounts and Schedule of Lands acquired and reserved during the Year under the Scenery Preservation Act. Pp. 11. (Wellington, N.Z.: W. A. G. Skinner.) 6*d*.

Journal of the Indian Institute of Science. Vol. 10B, Part 3: Intensity Variations of Madras (Port) Radio Station. By K. Sreenivasan. Pp. 35-42+3 plates. 8 annas. Vol. 10B, Part 4: Suspension Insulator Testing. By G. Yoganandam. Pp. 43-49+1 plate. 8 annas. (Bangalore.)

Report of the Royal Commission on Land Drainage in England and Wales. (Cmd. 2993.) Pp. 60. (London: H.M. Stationery Office.) 1*s*. 3*d*. net.

The Scottish Forestry Journal: being the Transactions of the Royal Scottish Arboricultural Society. Vol. 41, Part 2, October. Pp. 105-236+41-48. (Edinburgh: Douglas and Foulis.) 3*s*.

Proceedings of the Liverpool Geological Society. Session the Sixty-eighth, 1926-1927. Edited by C. B. Travis. Pp. xvii + 285-350. (Liverpool.) 5*s*.

Diary of Societies.

MONDAY, JANUARY 2.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 3.30.—Dr. E. H. Marshall: The Royal Research Ship *Discovery* in the Antarctic (Christmas Lectures for Young People) (I.).

VICTORIA INSTITUTE (at Central Hall, Westminster), at 4.30.—Rev. Dr. P. P. Flournoy: Christ and the Scriptures—What may we gather from His Attitude and Instruction? (Gunning Prize Essay, 1927).

BRITISH PSYCHOLOGICAL SOCIETY (Education Section) (in Botanical Theatre, University College), at 5.30.—Dr. D. Forsyth: Those First Five Years.

INSTITUTION OF AUTOMOBILE ENGINEERS (Bristol Centre) (at Merchant Venturers' Technical College, Bristol), at 6.45.—E. A. Watson: The Electrical Characteristics of Spark Gap and Sparking Plugs.

SOCIETY OF CHEMICAL INDUSTRY (London Section) (at Chemical Society), at 8.—Dr. J. C. Drummond: The Future of Biochemical Research.

TUESDAY, JANUARY 3.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. E. N. da C. Andrade: Engines: Engines which work to and fro (Juvenile Christmas Lectures) (III.).

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middlesbrough Branch) (at Middlesbrough), at 7.30.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Royal Society of Arts), at 7.45.—R. F. Engelbach: Some Notes on Reorganising a Works to increase Production.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.30.—Capt. T. A. Joyce: Further Researches at Lubaantun, 1927.

WEDNESDAY, JANUARY 4.

ROYAL SOCIETY OF ARTS, at 3.—Prof. A. Smithells: Flame (Dr. Mann Juvenile Lectures) (I.).

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—T. H. Gill and N. F. S. Hecht: Rotating Loop Radio Transmitters and their Application to Direction-finding and Navigation.—Dr. R. L. Smith-Rose and S. R. Chapman: Some Experiments on the Application of the Rotating Beacon Transmitter to Marine Navigation.—Dr. R. L. Smith-Rose: A Theoretical Discussion of Various Possible Aerial Arrangements for Rotating Beacon Transmitters.

INSTITUTION OF CIVIL ENGINEERS (Manchester and District Association) (at 36 George Street, Manchester), at 6.45.—J. S. Glen Primrose: Fatigue and Wear Testing of Materials.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS (at Caxton Hall), at 7.—G. U. Morgan: Oil Fuel Burning for Central Heating and Domestic Boilers.

ROYAL MICROSCOPICAL SOCIETY (Biological Section).

THURSDAY, JANUARY 5.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. E. N. da C. Andrade: Engines: Engines which work Round and Round (Juvenile Christma Lectures) (IV.).

LINNEAN SOCIETY OF LONDON, at 5.30.—Dr. Suzanne Leclercq and M. Belliere: *Psygmophyllum Gilkineti*, nov. sp. from the Middle Devonian of Malonne, Belgium.—Prof. S. H. Williams: A Naturalist in the Guiana Jungles.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—E. C. McKinnon: Storage Batteries in relation to Modern Supply of Electric Lighting and Power.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 6.30.—A. Fage: Some Recent Experiments on Fluid Motion.

INSTITUTION OF MECHANICAL ENGINEERS (Manchester Branch) (jointly with Manchester Association of Engineers).—E. G. Herbert: Cutting Temperatures: Their Effect on Tools and on Materials subjected to Work.

FRIDAY, JANUARY 6.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 3.30.—C. F. Rey: Abyssinia and the Blue Nile (Christmas Lectures for Young People) (II.).

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Prof. C. J. Hawkes: The Marine Oil-Engine (Thomas Lowe Gray Lecture).

SOCIETY OF CHEMICAL INDUSTRY (Manchester Section, jointly with Textile Institute) (at Engineers' Club, Manchester), at 7.—F. C. Wood and Agnes C. Alexander: The Action of Caustic Alkali on Partially-Methylated Cellulose—The Heat of Reaction and Absorption.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group, Informal Meeting), at 7.

GEOLOGISTS' ASSOCIATION (at University College), at 7.30.—Dr. A. Brammall: Dartmoor Detritals: A Contribution to the Study of Provenance.—A. W. Groves: Eocene and Pliocene Outliers between Chipstead and Headley, Surrey.—*To be taken as read*:—F. T. Ingham: The Petrology of the Spilsby Sandstone.

SATURDAY, JANUARY 7.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. E. N. da C. Andrade: Engines: Putting the Furnace in the Cylinder (Juvenile Christmas Lectures) (V.).

CONFERENCE.

JANUARY 3 AND 4.

INCORPORATED ASSOCIATION OF HEAD MASTERS (in the Guildhall, E.C.).

Tuesday, Jan. 3.

At 10.55.—G. Smith: President's Inaugural Address.

At 2.15.—What Commerce and Industry ask of Secondary Schools.

R. F. Cholmeley and others: What Secondary Schools ask of Commerce and Industry.

Educational Experiments:—

(*a*) H. W. Cousins: The School Curriculum in relation to Environment: an Account of an Experiment at Brampton County Secondary School.

(*b*) A. Lyon: Musical Adventure in a Secondary School.

Wednesday, Jan. 4.

At 11.15.—Wickham Steed: The Position of German in English Secondary Schools.

C. H. Lockitt and others: The Disabilities of Secondary School Pupils in Rural Areas.

At 2.15.—C. H. K. Marten: The Teaching of History in Secondary Schools.

H. Cradock-Watson: Bible Teaching in Secondary Schools.

Discussion on The Provision of Books and School Apparatus.

EXHIBITIONS.

JANUARY 6.

JUNIOR INSTITUTION OF ENGINEERS, at 6.—Exhibition of Instruments and Scientific Appliances.

JANUARY 10, 11, AND 12.

ANNUAL EXHIBITION OF THE PHYSICAL SOCIETY AND THE OPTICAL SOCIETY (at Imperial College of Science and Technology), from 3 to 6 and from 7 to 10.—Discourses at 8:—

Jan. 10.—A. Whitaker: Progress in the Recording and Reproduction of Sound.

Jan. 11.—V. E. A. Pullin: Recent Application of X-Rays.

Jan. 12.—Dr. J. W. T. Walsh: Artificial Daylight.

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Life and Death.

THE ages of the Jewish patriarchs as recorded in the Old Testament have provoked much discussion and speculation. Has the span of life decreased during the passage of the centuries? Census statistics show, at any rate in Great Britain, that the expectation of life at birth has increased considerably in recent years. This, however, does not necessarily mean increased longevity, and investigations on remains of men of periods about two thousand years ago suggest that the expectation of life in advanced ages has actually decreased. The men who survived in those days were necessarily of strong constitutions.

To those who may have hoped that science will soon provide the means whereby the span of human life may be prolonged, the critical consideration of the factors concerned in the onset of old age given by Sir Humphry Rolleston in the following pages will show that such hope is as yet vain. This does not necessarily imply, however, that the declining years of life cannot, in certain cases, be rendered less irksome.

As is well known, certain primitive organisms, such as Paramœcium, may be described as immortal. Why then are multicellular animals mortal? The mutual influence of the cells of the body upon one another appears to be the basis both for the rise of the multicellular animals in the scale of life and also for their mortality. In artificial cultures certain of the cells of the higher organisms can live and multiply indefinitely, provided that they are supplied with suitable nutriment and their waste products removed. But if the latter accumulate to any extent they exert an inhibitory action on the life and reproductive power of the cells: it appears possible, then, that some similar process may account for the gradual decay of the body's cells in old age.

On the other hand, one of the most important, if not the dominant factor, in determining the span of life, is inheritance, and this is acted on by the other factors, the sum of which forms the environment in its broadest sense. A favourable environment is produced by healthy living, especially the avoidance of excesses of every kind: and in such a case a very fair degree of mental and physical vigour may be retained even to the last. But few people escape lesions, produced by some kind of infection during the course of their life and tending to shorten it. Are there any means by which the span of life may be prolonged or old age rendered less irksome, by which, in fact, the body may be 'rejuvenated'?

On the hypothesis that old age is largely caused by the decay of those cells in the sexual glands which are responsible for the onset of puberty and the development of the secondary sex characters of the individual, Steinach and Voronoff have devised operations to increase the activity of these cells and thus postpone the onset of old age. They have claimed that, by stimulating the individual's own cells to increased activity or by supplying the necessary secretions from foreign cells introduced into the body by grafting, they have been enabled to prolong life and postpone senility in both animals and men. In so far as the symptoms of old age are due to the decrease in the secretions of these glands, it should be possible to relieve them by increasing the supply of these secretions, but to assume that the decrease in the latter plays the sole, or even the major part in the onset of old age, appears to be to take too narrow a view, considering the mutual influence which the cells of the body are known to exert upon one another.

There appears, then, to be no short cut to the abolition of old age and the prolongation of life. Each of us must watch his (or her) step from the day we are born. As Sir Humphry Rolleston expresses it: for a long life there are necessary "a judicious choice of parents, avoidance of disease and worry, moderation in all things, mental and physical exercise, an open-air life, serenity and charity to all men." The prescription seems simple, but the present and coming generations may find it increasingly difficult to carry out under the stress of life under modern conditions.

Concerning Old Age.[1]

By Sir Humphry Rolleston, Bart., K.C.B.

IN the simplest forms of animal life—the protozoa—which consist of a single cell, and so stand in the same relation to man that a brick does to a city, multiplication occurs by fission or division into two halves, and as there are now two cells instead of one and no vestige of a corpse, the organism is, as Weismann first insisted, immortal. This process may go on indefinitely, and has been watched by Woodruff in Paramœcium during 13½ years, for 8500 generations, comparable to a quarter of a million years of human life, without the occurrence of conjugation—namely, the union of two previously separate organisms, as occurs in the reproduction of higher animals—though periodically rejuvenation appears to take place by means of an independent internal re-organisation (endomixis) of a single cell. As the protozoa are, accidents apart, immortal, why is it that animals much higher in the scale never are? It has been shown by culture experiments that the individual cells of man's body are also potentially immortal, but that the necessary conditions for this cannot be realised when they form part of a highly differentiated and specialised complex whole. In the higher walks of the animal kingdom, rejuvenation of the constituent cells is thus rendered much more difficult or impossible, and the process of senescence must be regarded as the penalty for the high degree of individuation entailed in the complicated mechanism of the higher animals and man. But it is interesting to recall that in the humble planarian flat worms the life cycle may be dramatically changed: by starvation they not only become smaller, but also their structure becomes simpler, and their life cycle is reversed by the process of de-differentiation, reduction, or involution. By alternate starving and feeding, these flat worms have been kept stationary, while others passed through nineteen generations (C. M. Child), thus showing that the duration of existence of cells is not so much a matter of time as of the work or metabolic changes that go on inside them, although it may well be said that such a prolonged existence is not 'life' according to some views.

Although it is a far cry from amœbæ and flat worms to man, these biological results may have some remote bearing on the conditions influencing the duration of man's life. Not only diet—over- and under-feeding, the effects of gross feeding being obviously harmful—but also the more mysterious influence of the internal secretions provided by the ductless or endocrine glands, the thyroid, pituitary, and the gonads, the activities of which may well be modified by diet, must be taken into account. Disturbance of the endocrine balance, or the equilibrium normally maintained between the hormones or chemical messengers of these endocrine glands, has well-recognised effects on growth and metabolism, and so may influence the rate at which the body lives and wears or rusts out. The significance of the much-discussed 'rejuvenation' produced by Steinach's and Voronoff's operations on the sexual organs proves at any rate that there is much to learn, especially whether or not the duration of life is really prolonged thereby.

Biblical Ages.

The length of days ascribed to Methuselah (969), to Adam (930, or if the "conceit urged by learned men," as Sir Thomas Browne says, that he was 50 or 60 years old when called into being be accepted, making him 980 years at death), to Jared (962), to Seth (912), and others, has of course always excited curiosity. In "Arbor Vitae, or a Physical Account of the Tree of Life in the Garden of Eden," "translated out of the Latine of E. M. Arrais, M.D., Physician to John the IV King of Portugal, by Richard Browne in" 1683, there is a discussion as to the influence of the emanations of the Tree of Life, the eating of which and the resulting immortality were prevented by cherubims and a flaming sword turning every way, in endowing our first parents and their descendants with longevity, and the conclusion is reached that their length of life was due to the virtues diffused in the air, not only of Eden but also of the neighbouring countries, given off by fruit trees other than the Tree of Life in the Garden of Eden. The longevity of the patriarchs has called forth critical attempts at explanations on the basis of a difference in chronology. But though interesting and perhaps ingenious they are not very convincing; the suggestion that the reputed 'years' were lunar, not solar, containing thirty and not three hundred and sixty-five days, is too radical, for some of the patriarchs would on this interpretation have begotten children before they were ten years of age. The view that the year consisted of three instead of twelve months up to the time of Abraham, when it was extended up to eight months until the time of Joseph, when it first became our full complement of twelve

[1] Discourse delivered at the Royal Institution on Friday, May 13.

months, would make Methuselah's age 243 years, which is still excessive by modern standards. The probable explanation is that the patriarchal ages, like those of the mythical golden age of pre-history, existed solely in the minds of later scribes only too anxious to magnify the fathers of mankind. Antediluvian chronology may perhaps be compared with that of the Purānas, or the common scriptures of the ruling Aryan peoples of northern and western India, which contain fragments of truth and much that is imaginary, including in the last category the chronology (Rapson [2]).

The natural or physiological life of man has been thought to be a multiple of the period of growth. Hufeland, taking twenty-five years as the end of adolescence, and accepting Francis Bacon's view that animals live eight times as long as they take to come to maturity, optimistically arrived at two hundred years as the span of man's days on earth; Buffon multiplied fourteen, the age of puberty, by seven, and so concluded that a hundred years was the appointed time. Flourens, on rather different grounds, came to the same estimate, as did the often-quoted centenarian Luigi Cornaro, of Venice (1467–1566), and in more modern times Metchnikoff and Luciani. The number of reputed centenarians, especially in Russia (1 in 1000), Bulgaria (1 in 2000), California (1 in 10,000), and in Ireland (1 in 14,300), is at first sight imposing, but has been sternly discounted and cut down by George Cornewall Lewis, W. J. Thoms, and especially by T. E. Young's accurate investigations, and shown, contrary to the general view and other statistics, to be extremely small. Thus we must regard as fabulous the famous examples of Henry Jenkins, Thomas Parr, Katherine, Countess of Desmond, and probably other records, such as the Indian, quoted by Arrais on the authority of many Portuguese Indian governors, who lived more that 335 years, and the truthful tombstone in Carmarthen recording the death in 1831 of Ann David, aged 181 years.

Since the middle of the last century the great reforms in hygiene and sanitation in Great Britain prevented illness and premature death to such an extent that the expectation of life at birth has increased from 39·91 years in 1854 to 51·5 years in 1912 for males, and from 41·9 to 55·35 years for females. These official figures have been kindly given me by Dr. T. H. C. Stevenson, of the General Register Office, who tells me that provisional rough tables based on the 1921 census and recently published, but not official, show a further increased expectation of life. This increased expectation of life at birth is due to the prevention of death in early life, and is therefore very different from an increase in longevity. In fact, the statistical conclusion from investigations of the ages recorded on mummies in Egypt two thousand years ago by Karl Pearson, and others quoted by Raymond Pearl, is that the expectation of life at advanced periods has declined. Karl Pearson in 1902 found that, though a man of twenty-five lives on an average fifteen years more than one two thousand years ago, the expectation of life after the age of sixty-eight for a Romano-Egyptian two thousand years ago was greater than for an English man or woman of the same age, and pointed out that with these ancient people at about the beginning of the Christian era it was a case of the survival of the fittest, whereas the difference in the expectation of life at earlier ages is evidence of the great social and sanitary progress that has conquered environment.

While the Psalmist's estimate that "The days of our age are threescore years and ten; and though men be so strong that they come to four score years, yet is their strength then but labour and sorrow," is still the common experience; there are of course exceptions that we can all point to. In his prize essay on comparative longevity written in 1870, Sir Ray Lankester compared persons of abnormal longevity with giants in height which might range up to nine feet; but it is now known that these giants are morbid and examples of acromegaly, described by Pierre Marie in 1886, and it would be curious seriously to regard extreme longevity as a disease, as it is so obviously favoured by absence of that state. On balance, it may be still thought that the physiological age of man is a hundred years, though few there be that reach it. Women live longer than men; and among reputed centenarians also the ratio is much in favour of that popularly said to be the weaker sex; out of 691 reputed centenarian deaths during the ten years 1910–19 inclusive, 504, or 73 per cent., were females, and 187, or 27 per cent., males. In 1923 the numbers were 74 females and 22 males.

The reason for the limitation of life, in other words death, has naturally been much debated. Weismann suggested the thesis—a perverse extension of the theory of natural selection and survival of the fittest—that death was an adaptation advantageous to the race. Death, which has thus been evolved in the process of advance from a protozoan to the higher metazoan standard of existence, might be regarded as a provision against over-population and famine from insufficiency of

[2] Rapson, E. J., in the "Cambridge History of India," 1922, vol. 1, p. 305.

the food supplies of the world, and so the natural counterpart to modern artificial birth control. Miles Symner, professor of mathematics in Trinity College, Dublin, in the seventeenth century, calculated that in the 1400 years between the Creation and the Flood there would not have been standing room on the earth's surface if the patriarchs, with an average breeding period of four hundred years, begat a son every three years. With the present rapid increase of the world's population, thanks to improved sanitation, there have not been wanting estimations that, should no change occur, a few centuries will show the food supply of the world inadequate for its inhabitants (Raymond Pearl ; Ravenel).[3]

Metchnikoff considered death to be the result of intoxication from bacterial activity in the alimentary canal, and it has by many been ascribed to arterial disease ; the latter is no doubt a common cause of death, but not of the physiological termination of life. But a more satisfactory conception is an inherent constitution determined by heredity, the constituent cells being thus endowed with a certain store of vitality for themselves and their descendants, and that as this runs out the process of involution begins. Cell culture observations, however, suggest that there gradually develops in the cells a substance which inhibits their vitality. Carrel and Ebeling [4] found in cultures of fibroblasts the rate of multiplication and life *in vitro* varied in inverse ratio to the age of the fowl from which the blood plasma, used in the culture, was taken. It was also found that, with frequent washings to remove waste products, tissue cells can be cultivated indefinitely for years *in vitro* and have an unlimited capacity for multiplication (Carrel, Champy, and Grandcourt). It would thus appear that there is in old organisms a substance produced in the ageing cells which, entering the blood, exerts an inhibitory action on the life and reproductive power of the tissue cells. On the other hand, Raymond Pearl avoids the assumption of an inhibitory senescent substance in the blood plasma by the simple suggestion that the blood plasma of old animals is itself senescent, and so not such a good culture medium as the blood plasma of the young.

Factors influencing Longevity.

Experience and that pure and reformed summary of it known as statistics show, as Karl Pearson and A. Graham Bell's figures prove, that inheritance is one of the strongest factors, if not the dominant one, in determining the span of life. The other factors are extrinsic and may be included under the heading of environment in its broadest sense, if we may now use a word which in 1835 John Sterling, in reproaching Carlyle for so doing, described as "barbarous" and "without authority."

Numerous examples of families with long- or with short-lived tendencies will occur to every one ; but what heredity can do is perhaps more convincingly established by Raymond Pearl's striking table, from Bell's analysis of the Hyde family, showing the influence of parental ages on that of the offspring : among 184 persons whose parents both lived more than 80 years the average age at death was 52·7 years, whereas among 128 persons whose parents died before 60 years of age their average life was 32·8 years, or nearly 20 years less. Forsyth's investigation, carried out on strict actuarial principles, shows that if the reasonably preventable diseases be eliminated, the expectation of life, though increased, would not be so much prolonged as by the influence of a long-lived heritage. We should, therefore, both in our own and their interests, counsel our children to choose their parents carefully. As Benjamin Ward Richardson pointed out, the combined ages of one's parents and grandparents divided by six may be of assistance in numbering our days.

A sound stock may overcome the evil influence of environment, such as alcoholism and unhealthy surroundings in towns, and thus explain the occasional longevity of those whose lives have been far from blameless, and the contrast between two aged brothers, one sober, the other intemperate. But even with a poor inheritance care may extend the term of a useful and happy life. Sir Hermann Weber, by practising the precepts of his book on "The Prolongation of Life," led an active and happy existence until within a short time of his death at ninety-five, although his parents died at or before sixty years of age of heart failure and cerebral hæmorrhage—conditions due to high blood pressure and arterio-sclerosis.

Of the hereditary factors, inherent vitality of the nervous and the vascular systems are the most important ; the force of the nervous tissues calls the tune both in the mental disposition and the physical reactions of the body. As the late Sir William Osler remarked, much depends "on the quality of arterial tissue (vital rubber) which the individual has inherited." This statement, it may incidentally be mentioned, provides the answer to the question,

[3] Ravenel, M. P., The Gordon Bell Memorial Lecture, 1925, on "The Prolongation of Life. To what Goal is it Tending ?" *Am. Jour. Public Health*, New York, xvi. supplement to February number.
[4] Carrel and Ebeling, *Jour. Exper. Med.*, Baltimore, **34**, 599 ; 1921.

"What internal evidence is there that Osler has had an unhappy experience with cheap bicycles?" set in an examination paper, analogous to Calverley's famous examination paper on "The Posthumous Papers of the Pickwick Club," on his textbook of medicine. Cazalis' aphorism, "Man is as old as his arteries," is true in so far as the state of the vessels is in certain respects a good index of his prospects, for their condition may be largely determined by heredity, or deteriorated by disease or undue strain, and so provides a record of his family history and personal adventures; but the converse, "the arteries are as old as the man," would not hold good, for arteriosclerosis is not necessarily well marked in very old people.

Bodily Conformation.—The long-lived are usually spare and very seldom fat, neither very tall nor very short, very heavy, nor very light. Insurance companies are naturally much interested in the bearing of the body-build on longevity, and in America much statistical investigation has been started into problems such as the bearing in persons above the average weight, of the length of the spine, and a comparison of the chest and abdominal girths. From the insurance companies' statistics Dublin [5] found the following rather surprising and confusing results:—Among those over the average weight the prospect of life was better among short and medium height men with short relative spine-lengths and with chest girths below the average, and among overweight tall men the outlook was best in those with long relative spine-lengths and chest girths below the average. So that in both of these groups of men above the average weight the presence of a chest measurement below the average was an asset.

Taking *environment* in its widest sense, the influence of disease in damaging the tissue cells and in accelerating degeneration and atrophic processes resembling those which normally occur must be given due weight. It has been said that only those who have kept their bodies free from disease up to the age of 60 can expect to attain extreme old age (Saundby); but nearly half of the 824 persons between the ages of 80 and 100, analysed by Sir George Humphry, had passed through a severe illness, many of them acute infections. It seems highly probable, however, that the influence of an acute illness; the resulting changes being often transient and recoverable, would be much less harmful than that of a long-continued infection or intoxication in producing permanent changes. There are exceptions, and a terribly notable one is encephalitis epidemica, the 'sleepy sickness' of the lay press. Chronic infections, especially those in connexion with the teeth, are prone to cause rheumatoid arthritis, and the resulting limitation of activity does harm both to the general health and also mentally by impressing the idea of future crippling and incapacity. Acute illness may undoubtedly be the apparent starting-point of old age, more particularly if insufficient time, holiday, and change of scene be not allowed for recovery, the time allotted increasing roughly with the nature of the illness and the patient's age. The influence of infections, such as malaria, which Dr. W. H. S. Jones has shown was an important factor in the decadence of Magna Graecia, and of syphilis, both on the collective and individual health and longevity, need not be laboured.

The ideal of medicine is the prevention rather than the cure of disease, and for this end the detection of the earliest stages, and better, of the disposing causes of diseases, is essential. Timely warning about diet, exercise, and manner of life may do much to prevent disease from getting a firm seat on a man's back, and it is not without significance that life assurance companies in America have found it pay to provide periodic medical overhauls to their clients.

Functional activity, mental and physical, plays a great part in keeping the body, when free from disease, trim and slim and in postponing the advent of morbid old age. Occupation with a keen desire to carry it through is so beneficial that some, such as Karl Marx, would regard old age as largely a question of will power. Speaking of the circle in which Madame du Deffand moved, Lytton Strachey [6] says: "They refused to grow old; they almost refused to die. Time himself seems to have joined their circle, to have been infected with their politeness, and to have absolved them, to the furthest possible point, from the operation of his laws. Voltaire, d'Argental, Moncrif, Henault, Madame d'Egmont, Madame du Deffand herself, all lived to be well over eighty, with the full zest of their activities unimpaired."

Retirement is a problem beset with anxiety and danger; a successful business man when relieved of routine and able to indulge in idle luxury and without hobbies may rapidly degenerate. He now has to find occupation to kill time instead of time to do all he must; he begins to feel that 'his day is done,' that he has little but his dinner to look forward to, and that at last he is old and a 'has been.'

[5] Dublin, L. I., De Lamar Lectures, 1925–1926, p. 113.

[6] "Books and Characters," p. 83, London, 1922.

Thus auto-suggestion, even if not helped by suggestion from outside, hurries him on the downward path; any trifling ailment, such as rheumatism or indigestion due to overfeeding, may arouse very hypochondriacal anticipations, and observation of contemporaries with premature senile changes may feed the flame of this destructive auto-suggestion. There is, therefore, a basis for the idea that senility is catching, and for seeking the companionship of the young and thereby letting auto-suggestion work in a constructive direction. A well-occupied mind, a happy disposition that thinketh no evil, naturally smiles instead of frowning on a stranger or a new idea, free from anger, hatred, and jealousy, the vice that gives no pleasure to any one, and an attitude of charity in its original and best sense to all, tend to prolong life and make it a happy, healthy prelude to crossing the bar. In Sir James Crichton-Browne's words, "the best antidote against senile decay is an active interest in human affairs, and those keep young longest who love most."

As showing the influence of long-continued active work, reference may be made to the longevity of dignitaries of the church and the bench, and Prime Ministers, though these are no doubt supermen. Among painters there are some examples of very long lives fully occupied up to almost the end—Giovanni Bellini, Michelangelo, Sidney Cooper, Luke Fildes; Titian, for example, was painting with "incomparable steadiness of hand" when cut off by the plague at ninety-nine. Public duties may provide a means of useful and health-maintaining activity; thus during recent years there have been two octogenarian Lord Mayors of London, Sir Thomas Crosby (1911) and Sir John James Baddeley (1921). Compulsory retirement on attaining an age limit in the civil and military services, and now at the older universities, may not always be in the best interests of the individual or of the community; but as the majority of septuagenarians suffer in greater or less degree from pathological old age, it is a good general rule; and those who fall under the axe may comfort themselves on escaping the danger of epitaphs, which add another terror to death, like that bestowed in the "Reminiscences of the University, Town, and County of Cambridge," begun by Henry Gunning when he was over eighty, to the effect that "Professor Edward Christian died in 1823 in the full vigour of his incapacity."

Food.—Experience, ancient and modern, both lay, such as is set forth in Cornaro's "Discourses on a Sober and Temperate Life" (1558), and medical, as contained in the works of the great George Cheyne (who at one time weighed 32 stone before he became a vegetarian), author of "An Essay of Health and Long Life" (1724), Metchnikoff, Henry Thompson the surgeon, and Hermann Weber the physician, agree on the importance of moderation in food. Most centenarians have been small eaters, especially of meat, and there is this advantage in poverty and living on Abernethy's earned sixpence a day, or its present-day equivalent. Excess of food, though more gradual in its evil influence, is more generally destructive than alcoholism, and there is much wisdom in Montaigne's dictum, "Man does not die, he kills himself," and in the more dramatic proverb, "You dig your grave with your teeth." As already mentioned, in some lowly forms of life, such as planarian worms, partial starvation prolongs life, and there have not been wanting 'cures' on such economical lines. A simple diet throughout life, and, after growth is completed, obedience to the rule of ceasing to eat before a feeling of repletion cries, 'Hold, enough,' can be confidently recommended.

The influence of alcoholic drinks has been much discussed, and here, as in most problems, the influence of personal predilections may unconsciously tinge our conclusions. But there seems no doubt from collective investigations, such as Sir George Humphry inspired, and insurance companies provide, that hard drinkers are exceptional among the long-lived, and that among the characteristics of those who attain great length of days temperance finds a place. But in spite of the opinion of some enthusiasts that the choice of total abstinence is the only sure path to longevity, the recent investigation, undertaken with all a modern statistician's precautions against fallacies, by Prof. Raymond Pearl[7] on more than 5000 individuals at Baltimore, gives the perhaps not unwelcome verdict that "a moderate use of alcohol does not tend to shorten life." Such an opinion, based on sound data, is of unquestionable value; and this I gladly admit, for my impression was that long-continued and constant absorption of alcoholic drinks, though always moderate and never amounting to intoxication, did tend to age the conscientious devotee; but a few positive instances are apt to make an undue impression. What constitutes a 'moderate use' is open to the criticism brought by Sir Hermann Weber,[8] that what may be so for

[7] Pearl, R., "Alcohol and Longevity," 1926; and leading article, *Brit. Med. Jour.*, 1927, i. 528.

[8] Weber, Hermann, "On Means for the Prolongation of Life," p. 119, 1908.

one is excess for another; and the proverb, "Wine is the milk of old people," has been countered, as is the habit of proverb quoters, with "*Vinum lac veneris*," and the danger of exposure to other risks. In forming a conclusion in any given case about the question, to drink or not to drink, the personal equation of the individual must weigh heavily. No doubt total abstinence may suit some better and some worse, and while it certainly eliminates the problem of what is moderate, it equally deprives the aged of the help and comfort that some undoubtedly thus receive.

Smoking is on rather a different footing from excessive eating and drinking; as Calverley said, "Stories, I know, are told not to thy credit," but whatever may be true of the effects of the injection of nicotine into cats and rabbits, tobacco smoking has not been proved to cause arterio-sclerosis in man. As Sir Clifford Allbutt, a non-smoker and with a peculiar susceptibility to tobacco smoke, pointed out, if in any way it does cause arterial disease, the process is so slow, at any rate in most people, that its effects become so mingled with other manifestations of old age as to be almost impossible to discriminate; further, as Ruffer[9] proved by examination of mummies, the ancient Egyptians (1580 B.C.–A.D. 525) certainly had arterio-sclerosis without the consolations of tobacco. There is no doubt that the tolerance to tobacco painfully acquired in youth commonly diminishes with advancing years, and that unpleasant symptoms ranging from irregularity of the heart, abdominal pain to tobacco angina may be the means of transforming a previously inveterate smoker into a total abstainer. Sir George Humphry,[10] also a non-smoker, specially investigated the habits in this respect of centenarians; among 19 men, 8 smoked much, 1 a little, 10 not at all; of 30 female centenarians, 4 smoked much, 2 moderately, and 24 not at all. It is possible that, as in many people it diminishes appetite, smoking may exert a beneficial influence by preventing over-eating.

There are statistics to show that people in the country live longer than those in towns.

The advice then to give others, and even to practise ourselves, should include a judicious choice of parents, avoidance of disease and worry, moderation in all things, mental and physical exercise, an open-air life, serenity and charity to all men. Leonard Williams's epigrammatic summary is easier to remember: "Fresh air, meagre food, freedom from care."

The onset of what is popularly called old age varies in different countries: for example, the wheels of life run much faster in tropical countries, such as India, than in temperate latitudes. In the same race there is considerable variation: one man at sixty is prematurely senile—the subject of pathological old age—whereas another aged eighty is vigorous in body and alert in mind. In women the menopause is a milestone, and at any rate is the frontier of the territory of old age. There has been said to be a similar climacteric in man at fifty or sixty, due to changes in the reproductive organs, but without, I believe, any solid foundation; it may be a survival of the ancient conception of the grand climacterics at 49 (a multiple of the number 7), at 63 (7 multiplied by the magical number 9 of the Arabians), and at 81. Sir Henry Holland in 1873 described the "climacteric disease," which admittedly seldom came on without some previous event, such as cold, gout, a bout of drinking, recent marriage, or bereavement. There can be no possible shadow of doubt that after an illness recovery becomes slower as the years roll by, and that often, especially when the proper period of convalescent repose is abbreviated, the onset of old age is first noticed after an illness; the moral is to hurry slowly after illness, be it influenza, operation, or worse.

A senile climacteric about the latter part of the seventh or eighth decade in man, marking the dividing line between old age and decrepitude, as drawn in Chapt. xii. of Ecclesiastes, has been described by Nascher, but it cannot be regarded as comparable to the menopause in the other sex. To put the beginning of old age at fifty or even sixty in man would no doubt raise the protest that it is only the elastic period of middle age. In truth there is so much variation that a rigid date cannot be fixed. In healthy people the advent of old age is so gradual that the individual himself has no suspicion of it, and very likely secretly preens himself on looking ten years younger than his years and his contemporaries, whose changed appearance arouses self-congratulation rather than self-examination. Perhaps the suspicion suddenly breaks upon him by overhearing a chance remark of others, by seeing an unwonted reflection of his figure in a mirror, or by some nice girl offering him her seat in an omnibus. Or a holiday may break to him that he cannot walk as of yore because of undue fatigue, or he is held up by shortness of breath or pain on unwonted exertion.

[9] Ruffer, M. A., *Jour. Path. and Bacteriol.*, Cambridge, **15**, 453; 1911.
[10] Humphry, G. M., "Old Age," pp. 58, 63.

The Physiology of Old Age.

While the whole body does not age at the same rate, there is a general and progressive diminution in functional activity corresponding to the atrophic involution of the cells of the organs and tissues. The response to stimuli of all sorts is diminished, and this sluggish reaction contrasts with the ready and comparatively exaggerated response to both normal and pathological stimuli in early life. The popular opinion that age is second childhood may be correct in that there is some resemblance between undeveloped and failing mental and physical powers, but there is an enormous difference between the ever actively moving child and the impassiveness of real old age. This failure of the power of reacting to stimuli is seen in the sense organs; few people over sixty have perfect hearing, although most of us do not know it; and, apart from loss of acuity, they often do not take in general conversation so well as others unless their attention is braced up for the purpose. The emotions are less active, the death of friends is less of a grief, and so the individual tends to become isolated and to live more on past than on present-day impressions; hence a well-educated man may become more composed and satisfied, whereas one without intellectual interests may sink into mental torpor, vanity, and egocentricity, with the development of fads about health, undue garrulity, and a confirmed attitude of the *laudator temporis acti*. In what may be regarded as normal old age psychical activity wanes; new ideas do not bubble up, and when brought to the notice are not impetuously accepted. On the other hand, there is more of the philosophic calm born of what, when twitted with impatience, the young university don dismissed as "that greatly overrated property experience." Forgetfulness first of names, and much later of recent events, and mental fatigue are other evidences of the change. With loss of memory comes the habit of repeating the same story or remark, of mislaying things, and of becoming careless about the external graces.

Statements that the race is all to "the younger generation," and that forty marks the end of useful work in the world, are of course exaggerations, and many examples could be brought forward of masterpieces in art, literature, and science which have come from men much above that age. But taking the average, it must be admitted that the elasticity, imaginative power, and originality of mind that produce works of genius and great advances are seldom found in those who have two score years and ten to their credit. In the early stage, when a suspicion of the approach of age begins to dawn, there may be defensive action in the apeing of the young, so as to conceal the true age: a man may withdraw the date of his birth from "Who's Who" and other books of reference, and a mother has been known to delay the coming-out of her daughter.

While calmer and of more mature judgment as a rule, many, but perhaps not quite normal, old people become more anxious and apprehensive; like their gait, their will power is hesitant. In old animals the instinct of self-preservation seems to fade, and as their time draws nigh have perhaps, if we could only know, a desire for death, comparable to that for "his brother Sleep"; old people, though they often complain of their state, generally have what Matthew Arnold called "passionate, absorbing, almost blood-thirsty clinging to life." This, however, is not universal, and shortly before the end often disappears so that death is regarded as a welcome release, as is borne out by the famous William Hunter's last words when only sixty-five, "If I had strength enough to hold a pen, I would write how easy and pleasant a thing it is to die."

Muscular power and ability to walk as far and as fast as of yore diminish; the muscles and the glands of the intestine become sluggish so that constipation results; the diminished secretion of cutaneous perspiration makes the skin dry, and the bodily exchanges, as shown by basal metabolism estimations, are less (Aub and Dubois[11]; Legrand[12]). But except that the temperature in the axilla is lower than normal on account of the diminished blood supply to the skin, the internal temperature of the body is not, as might be expected, and indeed has been stated, lowered. The explanation appears to be that, although there is less heat produced in the body, there is less loss of heat from the dry skin on account of its poor vascular supply. Diminished sensibility to pain, both mental and bodily, is a beneficial relief, and suggests that with the gradual involution and approach to physiological death this warning will no longer be needed. This in some degree accounts for the latency of disease, such as pneumonia, urinary calculi, gallstones, or cancer, sometimes shown by the aged. There are, however, exceptions, such as pain after zona (shingles) and obstinate itching. Sleep is less continuous than in youth, and early waking is common. Recovery from illness

[11] Aub and Dubois, *Arch. Int. Med.*, Chicago, **19**, 823; 1917.
[12] Legrand, R., *Rev. franç. de l'encrinolog.*, Paris, **4**, 199; 1926.

is slower, wounds and fractures of bones take longer to heal, and intracapsular fracture of the neck of the femur, which is prone to occur from the thinning of the bone and the altered angle at the junction of the shaft and the neck of the bone, is a serious accident, often followed, as if it were the last straw, by dissolution. The old react somewhat differently to drugs, responding less promptly, so that some, such as purgatives, may be needed in considerable quantities. On the other hand, tolerance, as to tobacco, may become so much diminished that idiosyncrasies to certain drugs may appear; morphine should be preceded by a previous dose of atropine to protect the senescent respiratory centre from being put to sleep, but the old are scarcely so susceptible as children to this drug.

Though a gradually rising blood pressure is commonly seen to accompany the passing years, a high blood pressure is not a feature of old age; in fact, it might be said that those who attain great length of days do so, in part at least, because they have not had a high blood pressure to wear out and thicken their blood vessels. The pulse often shows intermittence (extrasystoles); this was so in one-fifth of the 824 persons analysed by Sir George Humphry, and though sometimes a cause of annoyance is not of any import.

Normal Structural Changes in Old Age.

Just as it may be difficult to state dogmatically that an old person is purely in a state of physiological senescence, as opposed to a condition in which past illnesses and infections have played a part so that there is a combination of physiological and morbid influences—of senescence and senility—so it may be hard to draw a hard-and-fast line between the structural changes of physiological involution and atrophy and those that may be regarded as pathological, especially as disease may accelerate the involutionary changes. It is probable that the ideal of physiological involution is so rare that at best the changes are but relatively physiological. The general atrophy is shown by loss of weight, for how rare it is that a really old person is fat, in fact, obesity is a sign that the normal metabolism, or exchanges in the body, is not physiological. The atrophic process does not proceed equally in all the constituents of the body; the nobler active cells are much more affected than the supporting fibrous tissues. The nerve cells in the brain and spinal cord become small, degenerated, and pigmented, and the brain as a whole weighs less. Arcus senilis, though occasionally seen in early life, is like grey or white hair, an accompaniment of age and due to degeneration; changes in the crystalline lens cause presbyopia, which may be brought on prematurely by toxæmia, it is said, of intestinal origin (E. Clarke).

The fall of the hair is not necessarily confined to the aged; a rare, but curious, effect is that after illness naturally brown hair has been reported in place of that previously white. The skin becomes dry, glossy, inelastic like parchment, and wrinkled from atrophy of the fat, muscle, and elastic tissue, especially on the backs of the hands. From diminution of the blood supply there is an ivory pallor somewhat relieved by pigmented areas and dark brown patches of seborrhœic eczema; when in such a condition of impaired resistance the skin readily becomes damaged and is prone to infection, so that pruritus and even indolent ulcers may result. From atrophy of fat the veins become more prominent, and the appearance of small red angiomas on the trunk is common in middle age.

Like the hair, the teeth become few; Sir George Humphry found that above eighty years of age the average number left was six in men and three in women; it may not be so many now. Sir Isaac Newton, however, at the age of eighty-five was said to have lost only one tooth. The loss of teeth might perhaps be regarded as a hint that there is no longer need for so much food. With the loss of teeth the lower jaw returns to its shape in the infant, hence the 'nutcracker' aspect of the edentulous face. The bones of the skeleton get thinner, but retain their length and usually their form. The back becomes bowed from muscular weakness, but the cartilages of the ribs and the larynx do not become calcified except as a pathological event comparable to calcification of the arteries. It is interesting to speculate if there is any relation between the atrophy of bone and the enlargement of the prostate which occurs in a certain number of elderly men; for Grove and Vines found a deficiency of calcium in the blood of patients with enlarged prostates, and obtained benefit by giving extract of parathyroid gland, which controls calcium metabolism.

The heart is probably less altered than the other organs and tissues of the body, and indeed its efficiency must be essential for prolonged existence, as may be shown by statistics to the effect that from sixty to ninety years of age death is more often due to failure of the circulatory system, sometimes a blessed painless passing away in sleep, than to any other cause, whereas before sixty, failure of

the respiratory system is most responsible; to keep the heart in a healthy condition exercise is important.

The blood of healthy octogenarians does not necessarily show any change in the number of the red blood corpuscles and the amount of hæmoglobin, though pallor of the skin may suggest an anæmia which does not exist. Sometimes there is secondary anæmia resembling the Addisonian type; this is either due to morbid influences or to a more advanced atrophy and involution of the red bone marrow than usually occurs. The lymphatic glands, the spleen, and the leucoblastic bone marrow all, like the other organs, diminish in size, but this does not appear to influence the leucocyte count.

As already mentioned, arterio-sclerosis is neither the necessary accompaniment nor the cause of healthy old age. But it is very frequent in old people, and often causes premature senility, renal disease, and difficulty in walking (intermittent claudication or limp).

The endocrine glands share in the general involution, but in spite of attempts to find in them, and especially in the thyroid and the interstitial cells of the gonads, the elixir of life, this desideratum is still to seek.

The sexual organs slowly atrophy, with the exception that the prostate gets larger in most men after the age of fifty, though a small percentage only of them suffer from it. The formation of fibro-myomatous tumours of the uterus and of cystic involutionary changes in the mammary glands of women appear to be analogous to that in the prostate.

Healthy and Pathological Old Age.

From the time of Terence, Cicero, and Sanatorius, old age has been regarded as a disease, and Samuel Johnson remarked, "My diseases are an asthma, a dropsy, and, what is less curable, seventy-five." But it is important to remember that there are two kinds of old age: (i) The healthy old age, which I almost called the normal, but perhaps, as this might imply that it is the usual or average form, it is better not so described; and (ii) the commoner, in which the body has not simply grown old, but shows the relics and results of past disease, accumulated in the passage of years. It has been said, and with fair probability, that most people over sixty years of age have some focus of infection, such as those in connexion with the teeth, the accessory nasal sinuses, the prostate, or gall bladder; these sources of poisoning undermine the general health and age the tissues, especially when they are beginning to undergo the natural process of involution and atrophy. To draw a hard-and-fast line between healthy old age (senescence) and old age partially caused by some disease may, in individual instances, be difficult or even impossible; they so often overlap. It is, however, observance of pathological old age that accounts for the pity, if not dislike, with which it is commonly viewed, and for the opinion expressed by many people that they have no wish to live to a great age.

The influence of adverse conditions, unhealthy surroundings, infections, and disease in shortening life and producing a pathological, that is, unnatural, old age is seen by comparing the physiological existence of man, which not unreasonably may be put at a hundred years, with the average expectation of life at birth in England and Wales—55·35 years for females and 51·5 years for males. The age of fifty to sixty is that when some common diseases, such as arterio-sclerosis, failing heart, kidney disease, cerebral hæmorrhage, liver disease, and cancer, take a heavy toll. Those who survive with cardio-vascular disease are prematurely restricted in their activities and so help to increase the unhappy impression that advancing years has in the popular mind.

There are many definitions of disease, or 'want of ease,' and as good a one as any is a want of adjustment between the individual and his surroundings. The frequency with which those advanced in years suffer pain and discomfort is evidence of more than length of days; for example, rheumatism is the result of some focus of infection. Arterio-sclerosis, the result of past or present high blood pressure or of poisons—bacterial, metabolic, and of intestinal origin—is very common in old people, but is not, at least in an extreme degree, a necessary accompaniment.

The Description of Old Age in the Twelfth Chapter of Ecclesiastes.

In connexion with old age, every one must recall the famous description in the first six verses of the twelfth chapter of Ecclesiastes, beginning, "Remember now thy Creator in the days of thy youth, while the evil days come not, nor the years draw nigh, when thou shalt say, I have no pleasure in them." Formerly ascribed to King Solomon (977 B.C.), the Book of Ecclesiastes (in Hebrew Koheleth = the preacher) has been shown by the higher criticism to date only from the end of the third century B.C. In his attractive work, "A

Gentle Cynic,"[13] the late Prof. Morris Jastrow, jun., of Philadelphia, argued that the book of Ecclesiastes as it appears in the authorised version, consists of (i) the original, cynical, but good-natured *obiter dicta* of the unknown dilettante who preferred to veil his identity under the name of Koheleth; and (ii) additions and modifications made by various hands to render it more orthodox and compatible with the tradition that it was written by Solomon. Thus the admonition "of making books there is no end; and much study is a weariness of the flesh," may very probably have been intended as a hint that Koheleth's views should not be taken too seriously. Following this conception, Jastrow reconstructed the text of the book of Ecclesiastes to what he argued was its original form, and compared it with the more modern writings of Omar Khayyám and Heinrich Heine. As we all must have speculated over the correct interpretation of the various metaphors in this description of the last stage of life, the explanations offered by others, such as Andreas Laurentius[14] (1599), Master Peter Lowe[15] (1612), founder of the Faculty of Physicians and Surgeons of Glasgow, Bishop J. Hall[16] (1633), Richard Mead[17] (1775); and Jastrow may be very briefly mentioned. In 1666, John Smith devoted a book of 266 pages to elucidate these six verses which contain 207 words —"King Solomon's Portraiture of Old Age wherein is contained A Sacred Anatomy both of Soul and Body." He is peculiar in authorship on this subject at his early age, thirty-five years, for nearly all the other writers on this topic, such as Cornaro, Sir Anthony Carlisle, Charcot, Sir George Humphry, Sir Hermann Weber, and Robert Saundby, not to mention and embarrass those happily with us, have been approaching "the sere, the yellow leaf," and have perhaps been moved to their labours by the maxim, "Physician, cure thyself."

The second verse, "While the sun, or the light, or the moon, or the stars, be not darkened, nor the clouds return after the rain," is regarded by Laurentius, Lowe, and Hall as referring to the ocular disabilities of old age, whereas Smith and Mead consider that mental failure and depression are meant. As regards the third verse, "In the day when the keepers of the house [the hands] shall tremble, and the strong men [the legs] shall bow themselves [become bent], and the grinders [teeth] cease because they are few, and those that look out of the windows [the eyes] be darkened," there is general agreement, Lowe specially designating cataract as meant in the last sentence. "And the doors shall be shut in the streets" is regarded as referring to the mouth by Laurentius and Mead, and to the various orifices, including the results—constipation and dysuria—by Smith; "when the sound of grinding is low" is considered by Jastrow to mean impaired hearing, and by Smith as a lowered rate of metabolic processes, such as assimilation, blood formation, and various secretions. "And he shall rise up at the voice of the bird" implies, according to Smith and Mead, the early waking of the elderly; "and all the daughters of musick shall be brought 'low" signifies to Laurentius the failure of voice, to Mead deafness, and to Smith all the organs concerned with sounds —namely, the lips, tongue, larynx, and the auditory apparatus. "Also when they shall be afraid of that which is high, and fears shall be in the way" is regarded by Smith as describing the general mental attitude of anxiety for things both small and great and a bad head for height; but a more modern commentator suggests that "afraid of that which is high" refers to dyspnœa on climbing a hill. "And the almond tree shall flourish" is by Laurentius, Hall, and Smith thought to refer to the white hair or 'churchyard flowers' of the old, but Mead argued that loss of smell is meant. "And the grasshopper shall be a burden" has been very variously interpreted: Hall is content to accept the literal meaning that the least weight is a nuisance; Laurentius and Lowe understand œdema of the legs; John Smith that the aged body undergoes the reverse change of shrivelling, hardening, and angularity. In the sixth verse the words "or ever the silver cord be loosed" refer, according to Laurentius, Lowe, Mead, and Jastrow, to kyphosis, but Smith translates them into paralysis of the spinal cord and nerves. "Or the golden bowl be broken" signifies cardiac failure to Laurentius and Lowe, but cerebral hæmorrhage to Smith, who thus explains the next line, "or the pitcher [the veins] be broken at the fountain [the right ventricle], or the wheel [the arterial circulation] broken at the cistern [the left ventricle]," and therefore concludes that King Solomon was perfectly acquainted with the circulation of the blood discovered by William Harvey in 1616.

[13] "The Gentle Cynic, being a Translation of the Book of Koheleth, commonly known as Ecclesiastes, stripped of later Additions, also its Origin, Growth, and Interpretation," by Morris Jastrow, junior, 1919, J. B. Lippincott Co.

[14] Laurentius, A., "A Discourse of the Preservation of the Sight; of the Melancholic Diseases; of the Rheums; and of Old Age." Translated out of French into English by Richard Surphlet, 1599.

[15] Lowe, P., "The Whole Course of Chirurgerie," 1612.

[16] Hall, J., "Paraphrase upon the Hard Texts of the Whole Divine Scripture," 1633.

[17] Mead, R., "Medica Sacra." Translated from the Latin by Thomas Stark, 1755.

Diseases of Old Age.

The diseases of old age would make a long chapter. In each of the ages of man's strange eventful history some diseases are particularly prominent, and others very unusual or never occur; but, generally speaking, the influence of age consists in modifying the character rather than in initiating special forms of disease. A convenient method of considering the subject would be under the two heads of diseases (i) occurring in the aged, and (ii) those more or less confined to the last phase. Diseases common to all or most stages of life are in old age less acute, less dramatic, and more prone to be latent: in Charcot's words, the organs suffer in silence without any local or general disturbance, though sudden collapse may occur. Thus pneumonia, which Osler called "the friend of the aged," because by a short and rarely painful illness it relieves them from those "cold gradations of decay" that make the last stage of all so distressing, is often so latent that death is ascribed to senile decay.

There is, as already pointed out, a great contrast between early and late life in the reaction to disease; but in acute disease, contrary to what might be expected from what has been said about the sluggish response, there is no tendency to absence of fever in the aged. In life's journey the scars and effects of disease accumulate so that rheumatoid arthritis and crippling arterio-sclerosis and its results, and some forms of cancer, become more prominent. Dr. T. H. C. Stevenson, of the General Register Office, has kindly provided me with statistics showing that cancer is not a disease of the period from fifty to seventy, rather than of the more advanced old age; in fact, recent returns, with a few apparent and doubtful exceptions, show that, on the whole, mortality from cancer of the more accessible sites continues to increase up to extreme old age, whereas that from the less easily accessible does not, the decrease in extreme old age being greatest for cancer in parts of the body—the stomach and intestines—where it is more likely to escape detection.[18] In America it has been estimated that 10 per cent. of all old people die from unsuspected cancer (Wood[19]). It has, however, been argued that old age alone does not specially favour the development of cancer, and that the relationship is entirely indirect by providing opportunity for long-continued irritation (Murray[20]). In old age repeated exposure to the infections responsible for fevers, such as measles, scarlet, diphtheria, and typhoid, has produced a considerable degree of protection. Pneumonia and erysipelas, however, are prone to recur.

Many of the affections of the old are the result of arterio-sclerosis, a legacy of the middle period of life, which has continued to progress, and by interfering with the circulation produces serious degeneration in the important cells of the organs, especially in the central nervous system; thus from changes in the brain and spinal cord there result senile dementia and various forms of paralysis, and from implication of the arteries of the lower limbs difficulty in walking from cramp and intermittent claudication, and senile gangrene. There is a form of tremor in the elderly which often affects the head, and paralysis agitans or Parkinson's disease—so called after its describer, James Parkinson, a humble general practitioner in Hoxton, who was also a palæontologist and author of pamphlets advocating bloodless revolution—though not confined to old age, is most usual then; it is of particular interest because its features are closely imitated by the result of encephalitis epidemica, which since the War has been comparatively common in the young, and so is a good example of the degenerative effects of disease imitating those seen in advanced age.

[18] Stevenson, T. H. C., "The Registrar-General's Statistical Review for England and Wales, 1923," text, p. 69.
[19] Wood, F. C., *Jour. Am. Med. Assoc.*, Chicago, **83**, 569; 1919.
[20] Murray, J. A., Eighth Scientif. Rep. Imperial Cancer Res. Fund, p. 79, 1923.

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British Association Addresses.

A Message from H.R.H. The Prince of Wales, K.G., F.R.S., on Laying Down the Presidency of the Association.[1]

MY year of office as president of the British Association has come to an end, and I can only express my regret to the members of the Association, and to our hosts the City and University of Leeds, that I am unable to attend personally in order to take my leave.

At Oxford last year I ventured in my address to lay before the meeting a view of the relations between science and the State. I felt subsequently some justification for having chosen this topic, when I observed in the proceedings of the Imperial and Colonial Conferences of the past year the extraordinary emphasis laid upon the value of scientific research in relation to imperial development. Both conferences set up special committees on research, and we cannot but believe and rejoice that the foundations of an imperial scientific service are being firmly laid. The Prime Minister of Australia indicated "the application of science both to our primary and secondary industries" as "the most important thing for Empire trade"; more recently our ex-president, the Earl of Balfour, invited the attention of the House of Lords to "the enormous value of the work given by men of science, with the most lavish generosity," to the study of problems of the common welfare.

Such events as these place it beyond doubt that one of the main objects of the British Association itself is in process of achievement, namely, that of "obtaining more general attention for the objects of science." The Association, the so-called parliament of science, is one of the chief instruments to that end, and I trust that the public support will continue, in increasing measure, to be accorded to its work. Its powers, I am happy to say, have been very materially strengthened, during my own term of office, through the splendid generosity of Sir Alfred Yarrow, in making a gift of £10,000 for the general purposes of the Association, to be expended, in accordance with his wise provision, in the course of twenty years. I gladly take this opportunity of publicly repeating the thanks of the Association to Sir Alfred Yarrow.

In resigning the chair to Sir Arthur Keith, I can whole-heartedly congratulate the Association on its choice of my successor. His name stands very high in the science of man's origin and early biological history. I have reason to believe that when any one in this country digs up a bone his first instinct (subject to the intervention of the police) is to send it to Sir Arthur Keith. You are to hear from him an address on Darwinism as it stands to-day—a subject of perennial interest, and more than once one of warm controversy at our own meetings. The occasion of the presidential address does not (I am thankful to say) lend itself to controversy, but the warmth I am sure you will supply in your welcome to Sir Arthur Keith, and, meeting as you are in Leeds, that warmth will be increased by the traditional quality of Yorkshire hospitality.

EDWARD P., *President.*

[1] Read at the inaugural meeting of the Association in Leeds on Wednesday evening, Aug. 31.

Darwin's Theory of Man's Descent as it Stands To-day.[1]

By Prof. Sir Arthur Keith, M.D., D.Sc., LL.D., F.R.S.

MY first duty as your president, and it is a very pleasant one, is to send the following message in your name to H.R.H. The Prince of Wales :

Your Royal Highness,

The British Association for the Advancement of Science, now assembled in Leeds to begin another session, cannot allow your year of office to terminate without offering to you sincere and humble congratulations on the happy results which have attended your presidency. A year ago, in the historic city of Oxford, you did British science the signal honour of coming among us as our president ; the meeting you then inaugurated set a standard which future gatherings will strive to emulate. The inspiring message you then addressed to us, and through us to men of science in every part of the Empire, has already borne fruit. We are within sight of a closer union, for which the Association itself has always striven, between men of science overseas and their colleagues at home, in their endeavour to solve problems of Imperial concern. It is too soon as yet to assess the value of the harvest of science planted under your ægis, for the best vintages of science mature slowly, but of this we are certain : the interest Your Royal Highness has taken in the work of this Association will prove a permanent source of encouragement for all who work for the betterment of life through increase of knowledge. To-night we proudly add your presidential banner to those of the great men of science who have presided over this Association since its inception at York ninety-six years ago.

Subject of Address.

In olden times men kept their calendars by naming each year according to its outstanding event. I have no doubt that in future times the historian of this Association, when he comes to distinguish the presidential year which opened so auspiciously in Oxford twelve months ago, will be moved to revert to this ancient custom and name it the 'Prince's Year.' And I am under no misapprehension as to what will happen when our historian comes to the term which I have now the honour of inaugurating at Leeds ; he will immediately relapse to the normal system of numerical notation. Nor will our historian fail to note, should he be moved to contrast the meeting at Oxford with that which now begins at Leeds, that some mischievous sprite seems to have tampered with the affairs of this Association. For how otherwise could he explain the fortune which fell to ancient Oxford, the home of history ? To her lot fell a brilliant discourse on the application of science to the betterment of human lives ; while Leeds, a city whose life's blood depends on the successful application of science to industry, had to endure, as best she could, a discourse on the theme of ancient history. For the subject of my address is man's remote history. Fifty-five years have come and gone since Charles Darwin wrote a history of man's descent. How does his work stand the test of time ? This is the question I propose to discuss in the brief hour at my disposal.

The Opening Shot in the Darwinian Battle.

In tracing the course of events which led up to our present conception of man's origin, no place could serve as a historical starting-point so well as Leeds. In this city was fired the first verbal shot of that long and bitter strife which ended in the overthrow of those who defended the Biblical account of man's creation and in a victory for Darwin. On September 24, 1858—sixty-nine years ago—the British Association assembled in this city ; Sir Richard Owen, the first anatomist of his age, stood where I now stand. He had prepared a long address, four times the length of the one I propose to read, and surveyed, as he was well qualified to do, the whole realm of science ; but only those parts which concern man's origin require our attention now. He cited evidence which suggested a much earlier date for the appearance of man on earth than was sanctioned by Biblical records, but poured scorn on the idea that man was merely a transmuted ape. He declared to the assembled Association that the differences between man and ape were so great that it was necessary, in his opinion, to assign mankind to an altogether separate order in the animal kingdom. As this statement fell from the president's lips there was at least one man in the audience whose spirit of opposition was roused—Thomas Henry Huxley—Owen's young and rising antagonist.

Owen and Huxley.

I have picked out Huxley from the audience because it is necessary, for the development of my theme, that we should give him our attention for a moment. We know what Huxley's feelings were

[1] Presidential address delivered to the British Association at Leeds on Aug. 31.

towards Owen at the date of the Leeds meeting. Six months before, he had told his sister that "an internecine feud rages between Owen and myself," and on the eve of his departure for Leeds he wrote to Hooker: "The interesting question arises: shall I have a row with the great O. there?" I am glad to say the Leeds meeting passed off amicably, but it settled in Huxley's mind what the 'row' was to be about when it came. It was to concern man's rightful position in the scale of living things.

Man's Position in the Animal Kingdom.

Two years later, in 1860, when the British Association met in Oxford, Owen gave Huxley the opportunity he desired. In the course of a discussion Owen repeated the statement made at Leeds as to man's separate position, claiming that the human brain had certain structural features never seen in the brain of anthropoid apes. Huxley's reply was a brief and emphatic denial with a promise to produce evidence in due course—which was faithfully kept. This opening passage at arms between our protagonists was followed two days later by that spectacular fight—the most memorable in the history of our Association—in which the Bishop of Oxford, the representative of Owen and of orthodoxy, left his scalp in Huxley's hands. To make his victory decisive and abiding, Huxley published, early in 1863, "The Evidences of Man's Place in Nature," a book which has a very direct bearing on the subject of my discourse. It settled for all time that man's rightful position is among the Primates, and that as we anatomists weigh evidence, his nearest living kin are the anthropoid apes.

Owen's Opinion of Darwinism.

My aim is to make clear the foundations on which rest our present-day conception of man's origin. The address delivered by my predecessor from this chair at the Leeds meeting of 1858 has given me the opportunity of placing Huxley's fundamental conception of man's nature in a historical setting. I must now turn to another issue which Sir Richard Owen merely touched upon, but which is of supreme interest to us now. He spent the summer in London, just as I have done, writing his address for Leeds and keeping an eye on what was happening at scientific meetings. In his case something really interesting happened. Sir Charles Lyell and Sir Joseph Hooker left with the Linnean Society what appeared to be an ordinary roll of manuscript, but what in reality was a parcel charged with high explosives, prepared by two very innocent-looking men—Alfred Russel Wallace and Charles Darwin. As a matter of honesty it must be admitted that these two men were well aware of the deadly nature of its contents, and knew that if an explosion occurred, man himself, the crown of creation, could not escape its destructive effects. Owen examined the contents of the parcel and came to the conclusion that they were not dangerous; at least, he manifested no sign of alarm in his presidential address. He dismissed both Wallace and Darwin, particularly Darwin, in the briefest of paragraphs, at the same time citing passages from his own work to prove that the conception of natural selection as an evolutionary force was one which he had already recognised.

The Transformation of our Outlook on Man's Origin.

As I address these words to you I cannot help marvelling over the difference between our outlook to-day and that of the audience which Sir Richard Owen had to face in this city sixty-nine years ago. The vast assemblage which confronted him was convinced, almost without a dissentient, that man had appeared on earth by a special act of creation; whereas the audience which I have now the honour of addressing, and that larger congregation which the wonders of wireless bring within the reach of my voice, if not convinced Darwinists are yet prepared to believe, when full proofs are forthcoming, that man began his career as a humble primate animal, and has reached his present estate by the action and reaction of biological forces which have been and are ever at work within his body and brain.

Darwin's Generalship.

This transformation of outlook on man's origin is one of the marvels of the nineteenth century, and to see how it was effected we must turn our attention for a little while to the village of Down in the Kentish uplands, and note what Charles Darwin was doing on the very day that Sir Richard Owen was delivering his address here in Leeds. He sat in his study struggling with the first chapter of a new book; but no one foresaw, Owen least of all, that the publication of the completed book, "The Origin of Species," fifteen months later (1859), was to effect a sweeping revolution in our way of looking at living things and to initiate a new period in human thought—the Darwinian period—in which we still are. Without knowing it, Darwin was a consummate general. He did not launch his first campaign until he had spent twenty-two years in stocking his arsenal with ample stores of tested and assorted fact. Having won territory with "The

Origin of Species," he immediately set to work to consolidate his gains by the publication in 1868 of another book, "The Variation of Animals and Plants under Domestication"—a great and valuable treasury of biological observation. Having thus established an advanced base, he moved forwards on his final objective—the problem of human beginnings—by the publication of "The Descent of Man" (1871), and that citadel capitulated to him. To make victory doubly certain he issued in the following year—1872—"The Expression of the Emotions in Man and Animals." Many a soldier of truth had attempted this citadel before Darwin's day, but they failed because they had neither his generalship nor his artillery.

History as written by Darwin.

Will Darwin's victory endure for all time? Before attempting to answer this question, let us look at what kind of book "The Descent of Man" is. It is a book of history—the history of man, written in a new way—the way discovered by Charles Darwin. Permit me to illustrate the Darwinian way of writing history. If a history of the modern bicycle had to be written in the orthodox way, then we should search dated records until every stage was found which linked the two-wheeled hobby-horse, bestrode by tall-hatted fashionable men at the beginning of the nineteenth century, to the modern 'jeopardy' which now flashes past us in country lanes. But suppose there were no dated records—only a jumble of antiquated machines stored in the cellar of a museum. We should, in this case, have to adopt Darwin's way of writing history. By an exact and systematic comparison of one machine with another we could infer the relationship of one to another and tell the order of their appearance, but as to the date at which each type appeared and the length of time it remained in fashion, we could say very little. It was by adopting this circumstantial method that Darwin succeeded in writing the history of man. He gathered historical documents from the body and behaviour of man and compared them with observations made on the body and behaviour of every animal which showed the least resemblance to man. He studied all that was known in his day of man's embryological history, and noted resemblances and differences in the corresponding histories of other animals. He took into consideration the manner in which the living tissues of man react to disease, to drugs, and to environment; he had to account for the existence of diverse races of mankind. By a logical analysis of his facts Darwin reconstructed and wrote a history of man.

Darwin's Position has become Impregnable.

Fifty-six years have come and gone since that history was written; an enormous body of new evidence has poured in upon us. We are now able to fill in many pages which Darwin had perforce to leave blank, and we have found it necessary to alter details in his narrative, but the fundamentals of Darwin's outline of man's history remain unshaken. Nay, so strong has his position become that I am convinced that it never can be shaken.

The Evidence of Fossil Remains.

Why do I say so confidently that Darwin's position has become impregnable? It is because of what has happened since his death in 1882. Since then we have succeeded in tracing man by means of his fossil remains and by his stone implements backwards in time to the very beginning of that period of the earth's history to which the name Pleistocene is given. We thus reach a point in history which is distant from us at least 200,000 years, perhaps three times that amount. Nay, we have gone farther, and traced him into the older and longer period which preceded the Pleistocene—the Pliocene. It was in strata laid down by a stream in Java during the latter part of the Pliocene period that Dr. Eugene Dubois found, ten years after Darwin's death, the fossil remains of that remarkable representative of primitive humanity to which he gave the name Pithecanthropus, or ape-man; from Pliocene deposits of East Anglia Mr. Reid Moir has recovered rude stone implements. If Darwin was right, then as we trace man backwards in the scale of time he should become more bestial in form—nearer to the ape. That is what we have found. But if we regard Pithecanthropus with his small and simple yet human brain as a fair representative of the men of the Pliocene period, then evolution must have proceeded at an unexpectedly rapid rate to culminate to-day in the higher races of mankind.

Man's Descent has not been in a Straight Line.

The evidence of man's evolution from an ape-like being, obtained from a study of fossil remains, is definite and irrefutable, but the process has been infinitely more complex than was suspected in Darwin's time. Our older and discarded conception of man's transformation was depicted in that well-known diagram which showed a single file of skeletons, the gibbon at one end and man at the other. In our original simplicity we expected, as we traced man backwards in time, that we should

encounter a graded series of fossil forms—a series which would carry him in a straight line towards an anthropoid ancestor. We should never have made this initial mistake if we had remembered that the guide to the world of the past is the world of the present. In our time man is represented not by one but by many and diverse races—black, brown, yellow, and white; some of these are rapidly expanding, others are as rapidly disappearing. Our searches have shown that in remote times the world was peopled, sparsely it is true, with races showing even a greater diversity than those of to-day, and that already the same process of replacement was at work. To unravel man's pedigree, we have to thread our way, not along the links of a chain, but through the meshes of a complicated network.

The Diversity of Form in Ancient Times.

We made another mistake. Seeing that in our search for man's ancestry we expected to reach an age when the beings we should have to deal with would be simian rather than human, we ought to have marked the conditions which prevail amongst living anthropoid apes. We ought to have been prepared to find, as we approached a distant point in the geological horizon, that the forms encountered would be as widely different as are the gorilla, chimpanzee, and orang, and confined, as these great anthropoids now are, to limited parts of the earth's surface. That is what we are now realising; as we go backwards in time we discover that mankind becomes broken up, not into separate races as in the world of to-day, but into numerous and separate species. When we go into a still more remote past they become so unlike that we have to regard them not as belonging to separate species but different genera. It is amongst this welter of extinct fossil forms which strew the ancient world that we have to trace the zigzag line of man's descent. Do you wonder we sometimes falter and follow false clues?

Discordant Evolution.

We committed a still further blunder when we set out on the search for man's ancestry: indeed, some of us are still making it. We expected that man's evolution would pursue not only an orderly file of stages but that every part of his body—skull, brain, jaws, teeth, skin, body, arms, and legs—would at each stage become a little less ape-like, a little more man-like. Our searches have shown us that man's evolution has not proceeded in this orderly manner. In some extinct races, while one part of the body has moved forwards another part has lagged behind. Let me illustrate this point because it is important. We now know that, as Darwin sat in his study at Down, there lay hidden at Piltdown, in Sussex, not thirty miles distant from him, sealed up in a bed of gravel, a fossil human skull and jaw. In 1912, thirty years after Darwin's death, Mr. Charles Dawson discovered this skull and my friend Sir Arthur Smith Woodward described it, and rightly recognised that skull and jaw were parts of the same individual, and that this individual had lived, as was determined by geological and other evidence, in the opening phase of the Pleistocene period. We may confidently presume that this individual was representative of the people who inhabited England at this remote date. The skull, although deeply mineralised and thick-walled, might well have been the rude forerunner of a modern skull, but the lower jaw was so ape-like that some experts denied that it went with the human fossil skull at all, and supposed it to be the lower jaw of some extinct kind of chimpanzee.

This mistake would never have been made if those concerned had studied the comparative anatomy of anthropoid apes. Such a study would have prepared them to meet with the discordances of evolution. The same irregularity in the progression of parts is evident in the anatomy of Pithecanthropus, the oldest and most primitive form of humanity so far discovered. The thigh-bone might easily be that of modern man, the skull-cap that of an ape, but the brain within that cap, as we now know, had passed well beyond an anthropoid status. If merely a lower jaw had been found at Piltdown, an ancient Englishman would have been wrongly labelled 'Higher anthropoid ape'; if only the thigh-bone of Pithecanthropus had come to light in Java, then an ancient Javanese, almost deserving the title of anthropoid, would have passed muster as a man.

Blanks still remain in the Geological Record.

Such examples illustrate the difficulties and dangers which beset the task of unravelling man's ancestry. There are other difficulties; there still remain great blanks in the geological record of man's evolution. As our search proceeds these blanks will be filled in, but in the meantime let us note their nature and their extent. By the discovery of fossil remains we have followed man backwards to the close of the Pliocene—a period which endured at least for a quarter of a million years, but we have not yet succeeded in tracing him through this period. It is true that we have found fossil teeth

in Pliocene deposits which may be those of an ape-like man or of a man-like ape; until we find other parts of their bodies we cannot decide. When we pass into the still older Miocene period—one which was certainly twice as long as the Pliocene—we are in the heyday of anthropoid history. Thanks to the labours of Dr. Guy E. Pilgrim, of the Indian Geological Survey, we know already a dozen different kinds of great anthropoids which lived in Himalayan jungles during middle and later Miocene times; we know of at least three other kinds of great anthropoids which lived in the contemporary jungles of Europe. Unfortunately we have found as yet only the most resistant parts of their bodies—teeth and fragments of jaw. Do some of these fragments represent a human ancestor? We cannot decide until a lucky chance brings to light a limb-bone or a piece of skull, but no one can compare the teeth of these Miocene anthropoids with those of primitive man, as has been done so thoroughly by Dr. William K. Gregory, and escape the conviction that in the dentitions of the extinct anthropoids of the Miocene jungles we have the ancestral forms of human teeth.

Date of Man's Emergence.

It is useless to go to strata still older than the Miocene in search of man's emergence; in such strata we have found only fossil traces of emerging anthropoids. All the evidence now at our disposal supports the conclusion that man has arisen, as Lamarck and Darwin suspected, from an anthropoid ape not higher in the zoological scale than a chimpanzee, and that the date at which human and anthropoid lines of descent began to diverge lies near the beginning of the Miocene period. On our modest scale of reckoning, that gives man the respectable antiquity of about one million years.

Proofs of our Anthropoid Ancestry.

Our geological search, which I have summarised all too briefly, has not produced so far the final and conclusive evidence of man's anthropoid origin; we have not found as yet the human imago emerging from its anthropoid encasement. Why, then, do modern anthropologists share the conviction that there has been an anthropoid stage in our ancestry? They are no more blind than you are to the degree of difference which separates man and ape in structure, in appearance, and in behaviour. I must touch on the sources of this conviction only in a passing manner. Early in the present century, Prof. G. H. F. Nuttall, of the University of Cambridge, discovered a trustworthy and exact method of determining the affinity of one species of animal to another by comparing the reactions of their blood. He found that the blood of man and that of the great anthropoid apes gave almost the same reaction. Bacteriologists find that the living anthropoid body possesses almost the same susceptibilities to infections, and manifests the same reactions, as does the body of man. So alike are the brains of man and anthropoid in their structural organisation that surgeons and physiologists transfer experimental observations from the one to the other. When the human embryo establishes itself in the womb it throws out structures of a most complex nature to effect a connexion with the maternal body. We now know that exactly the same elaborate processes occur in the anthropoid womb and in no other. We find the same vestigial structures—the same 'evolutionary post-marks'—in the bodies of man and anthropoid. The anthropoid mother fondles, nurses, and suckles her young in the human manner. This is but a tithe of the striking and intimate points in which man resembles the anthropoid ape. In what other way can such a myriad of coincidences be explained except by presuming a common ancestry for both?

The Evolution of Man's Brain.

The crucial chapters in Darwin's "Descent of Man" are those in which he seeks to give a historical account of the rise of man's brain and of the varied functions which that organ subserves. How do these chapters stand to-day? Darwin was not a professional anatomist and therefore accepted Huxley's statement that there was no structure in the human brain that was not already present in that of the anthropoid. In Huxley's opinion the human brain was but a richly annotated edition of the simpler and older anthropoid book, and that this edition, in turn, was but the expanded issue of the still older original primate publication. Since this statement was made thousands of anatomists and physiologists have studied and compared the brain of man and ape; only a few months ago, Prof. G. Elliot Smith summarised the result of this intensive inquiry as follows: "No structure found in the brain of an ape is lacking in the human brain, and, on the other hand, the human brain reveals no formation *of any sort* that is not present in the brain of the gorilla or chimpanzee. . . . The only distinctive feature of the human brain is a quantitative one." The difference is only quantitative but its importance cannot be exaggerated. In the anthropoid brain are to be recognised all those parts which have become so enormous in the human brain. It

is the expansion of just those parts which have given man his powers of feeling, understanding, acting, speaking, and learning.

The Evidence of Psychology.

Darwin himself approached this problem not as an anatomist but as a psychologist, and after many years of painstaking and exact observation, succeeded in convincing himself that, immeasurable as are the differences between the mentality of man and ape, they are of degree, not of kind. Prolonged researches made by modern psychologists have but verified and extended Darwin's conclusions. No matter what line of evidence we select to follow—evidence gathered by anatomists, by embryologists, by physiologists, or by psychologists—we reach the conviction that man's brain has been evolved from that of an anthropoid ape and that in the process no new structure has been introduced and no new or strange faculty interpolated.

Unexplained Problems.

In these days our knowledge of the elaborate architecture and delicate machinery of the human brain makes rapid progress, but I should mislead if I suggested that finality is in sight. Far from it; our inquiries are but begun. There is so much we do not yet understand. Will the day ever come when we can explain why the brain of man has made such great progress while that of his cousin the gorilla has fallen so far behind? Can we explain why inherited ability falls to one family and not to another, or why, in the matter of cerebral endowment, one race of mankind has fared so much better than another? We have as yet no explanation to offer, but an observation made twenty years ago by one on whom Nature has showered great gifts—a former president of this Association and the doyen of British zoologists—Sir E. Ray Lankester—deserves quotation in this connexion: "The leading feature in the development and separation of Man from other animals is undoubtedly the relative enormous size of the brain in Man and the corresponding increase in its activities and capacity. It is a striking fact that it was not in the ancestors of Man alone that this increase in the size of the brain took place at this same period—the Miocene. Other great mammals of the early Tertiary period were in the same case." When primates made their first appearance in geological records, they were, one and all, small-brained. We have to recognise that the tendency to increase of brain, which culminated in the production of the human organ, was not confined to man's ancestry but appeared in diverse branches of the mammalian stock at a corresponding period of the earth's history.

Darwin's Conception of Evolution Illustrated.

I have spoken of Darwin as a historian. To describe events and to give the order of their occurrence is the easier part of a historian's task; his real difficulties begin when he seeks to interpret the happenings of history, to detect the causes which produced them, and explain why one event follows as a direct sequel to another. Up to this point, we have been considering only the materials for man's history, and placing them, so far as our scanty information allows, in the order of their sequence, but now we have to seek out the biological processes and controlling influences which have shaped the evolutionary histories of man and ape.

The evolution of new types of man or of ape is one thing, and the evolution of new types of motor-cars is another, yet for the purposes of clear thinking it will repay us to use the one example to illustrate the other. In the evolution of motor vehicles Darwin's law of selection has prevailed; there has been severe competition and the types which have answered best to the needs and tastes of the public have survived. The public has selected on two grounds—first for utility, thus illustrating Darwin's law of natural selection, and secondly because of appearance's sake; for, as most people know, a new car has to satisfy not only the utilitarian demands of its prospective master but also the æsthetic tastes of its prospective mistress, therein illustrating Darwin's second law—the law of sexual selection. That selection, both utilitarian and æsthetic, is producing an effect on modern races of mankind and in surviving kinds of ape, as Darwin supposed, cannot well be questioned. In recent centuries the inter-racial competition amongst men for the arable lands of the world is keener than in any known period of human history.

The Production of New Types.

The public has selected its favoured types of car, but it has had no direct hand in designing and producing modifications and improvements which have appeared year after year. To understand how such modifications are produced the inquirer must enter a factory and not only watch artisans shaping and fitting parts together but also visit the designer's office. In this way an inquirer will obtain a glimpse of the machinery concerned in the evolution of motor-cars. If we are to understand the machinery which underlies the evolution of man and of ape, we

have to enter the 'factories' where they are produced—look within the womb and see the ovum being transferred into an embryo, the embryo into a fœtus, and the fœtus into a babe. After birth we may note infancy passing into childhood, childhood into adolescence, adolescence into maturity, and maturity into old age. Merely to register the stages of change is not enough; to understand the controlling machinery we have to search out and uncover the processes which are at work within developing and growing things and the influences which co-ordinate and control all the processes of development and of growth. When we have discovered the machinery of development and of growth we shall also know the machinery of evolution, for they are the same.

Machine and Animal Evolution Contrasted.

If the simile I have used would sound strange in Darwin's ear, could he hear it, the underlying meaning would be familiar to him. Over and over again he declared that he did not know how 'variations' were produced, favourable or otherwise; nor could he have known, for in his time hormones were undreamt of and experimental embryology scarcely born. With these recent discoveries, new vistas opened up for students of evolution. The moment we begin to work out the simile I have used and compare the evolutionary machinery in a motor factory with that which regulates the development of an embryo within the womb, we realise how different the two processes are.

Let us imagine for a moment what changes would be necessary were we to introduce 'embryological processes' into a car factory. We have to conceive a workshop teeming with clustering swarms of microscopic artisans, mere specks of living matter. In one end of this factory we find swarms busy with cylinders, and as we pass along we note every part of a car in process of manufacture, each part being the business of a particular brigade of microscopic workmen. There is no apprenticeship in this factory: every employee is born, just as a hive-bee is, with his skill already fully developed. No plans or patterns are supplied; every workman has the needed design in his head from birth. There is neither manager, overseer, nor foreman to direct and co-ordinate the activities of the vast artisan armies. And yet if parts are to fit when assembled, if pinions are to mesh and engines run smoothly, there must be some method of co-ordination. It has to be a method plastic enough to permit difficulties to be overcome when such are encountered and to permit the introduction of advantageous modifications when these are needed. A modern works manager would be hard put to were he asked to devise an automatic system of control for such a factory, yet it is just such a system that we are now obtaining glimpses of in the living workshops of Nature.

The Machinery of Development.

I have employed a crude simile to give the lay mind an inkling of what happens in that 'factory' where the most complicated of machines are forged—the human body and brain. The fertilised ovum divides and redivides; one brood of microscopic living units succeeds another, and as each is produced the units group themselves to form the 'parts' of an embryo. Each 'part' is a living society; the embryo is a huge congeries of interdependent societies. How are their respective needs regulated, their freedoms protected, and their manœuvres timed? Experimental embryologists have begun to explore and discover the machinery of regulation. We know enough to realise that it will take many generations of investigators to work over the great and new field which is thus opening up. When this is done we shall be in a better position to discuss the cause of 'variation' and the machinery of evolution.

The Machinery of Growth.

If we know only a little concerning the system of government which prevails in the developing embryo, we can claim that the system which prevails in the growing body, as it passes from infancy to maturity, is becoming better known to us every year. The influence of the sex glands on the growth of the body has been known since ancient times; their removal in youth leads to a transformation in the growth of every part of the body, altering at the same time the reactions and temperament of the brain. In more recent years medical men have observed that characteristic alterations in the appearance and constitution of the human body can be produced by the action of other glands—the pituitary, thyroid, parathyroid, and adrenals.

Under the disorderly action of one or other of these glands individuals may, in the course of a few years, take on so changed an appearance that the differences between them and their fellows become as great as, or even greater than, those which separate one race of mankind from another. The physical characters which are thus altered are just those which mark one race off from another. How such effects are produced we did not know until 1904, when the late Prof. E. H. Starling, a leader amongst the great physiologists of our time, laid bare an

ancient and fundamental law in the living animal body—his law of hormones. I have pictured the body of a growing child as an immense society made up of myriads of microscopic living units, ever increasing in numbers. One of the ways—probably the oldest and most important way—in which the activities of the communities of the body are co-ordinated and regulated is by the postal system discovered by Starling, wherein the missives are hormones—chemical substances in ultra-microscopic amounts, despatched from one community to another in the circulating blood. Clearly the discovery of this ancient and intricate system opens up fresh vistas to the student of man's evolution.

How Darwin would have welcomed this discovery! It would have given him a rational explanation to so many of his unsolved puzzles, including that of 'correlated variations.' Nor can I in this connexion forbear to mention the name of one who presided so ably over the affairs of this Association fifteen years ago—Sir E. Sharpey-Schafer. He was the pioneer who opened up this field of investigation and has done more than anyone to place our knowledge of the nature and action of the glands of internal secretion on a precise basis of experimental observation. With such sources of knowledge being ever extended, and others of great importance, such as the study of heredity, which have been left unmentioned, we are justified in the hope that man will be able in due time not only to write his own history but also to explain how and why events took the course they did.

In a brief hour I have attempted to answer a question of momentous importance to all of us—What is man's origin? Was Darwin right when he said that man, under the action of biological forces which can be observed and measured, has been raised from a place amongst anthropoid apes to that which he now occupies? The answer is Yes! and in returning this verdict I speak but as foreman of the jury—a jury which has been empanelled from men who have devoted a lifetime to weighing the evidence. To the best of my ability I have avoided, in laying before you the evidence on which our verdict was found, the rôle of special pleader, being content to follow Darwin's own example—Let the truth speak for itself.

Scientific Problems and Aspects.

Summaries of Addresses of Presidents of Sections.[1]

Outstanding Problems of Relativity.

In his presidential address to Section A (Mathematics and Physical Sciences), Prof. E. T. Whittaker refers first to the remark made by FitzGerald in 1894 that "Gravity is probably due to a change of structure of the æther, produced by the presence of matter," and discusses the relation of FitzGerald's views to Einstein's theory of gravitation. He then describes some of the consequences of general relativity, other than the well-known bending of light-rays by the sun and gravitational shift of spectral lines. Comments follow on the number of unsolved problems of the statical type, for which only the ordinary three-dimensional analysis is required, and which may therefore be attempted by those investigators who distrust their own powers of doing research in four dimensions. Reference is also made to connexions with the new wave-mechanics.

Prof. Whittaker then examines successively the relation of geometry to physics, and the place of electromagnetic phenomena in general relativity-theory, referring to the non-Riemannian geometries which have been suggested by Weyl, Eddington, Schouten, Wirtinger, and others.

This is followed by an inquiry into the axiomatics of the subject. The usual way of introducing relativity is to talk about measuring-rods and clocks, but Prof. Whittaker disapproves of this, and considers that the notions of 'length of material bodies' and 'time of clocks' are really rather complex notions which should not be introduced into the earlier chapters of axiomatic physics. He begins instead with the tracks of light-rays and of particles in the field, and shows how from them it is possible to construct the quadratic differential form which lies at the basis of the analytical theory, without introducing the notions either of length or of time. The next step is the assertion that the laws of Nature must be represented by equations which are covariantive with respect to this quadratic form with respect to all point-transformations of co-ordinates: after which the development of the theory proceeds in the usual way. By this procedure we obtain a geometry which is based entirely on light-rays and paths of particles, leaving open the question whether this is, or is not, identical with the geometry based on rigid measuring-rods. The results of the ether-drift experiments of

[1] The collected presidential addresses delivered at the meeting are published under the title "The Advancement of Science: 1927," at 6*s*., or may be obtained at the bookstall at Leeds by members for 4*s*. 6*d*.

D. C. Miller at Mount Wilson in 1925, if confirmed, would seem to indicate that the two kinds of geometry are actually different.

Prof. Whittaker then discusses the place of minimum-principles in physics. Gravitation acts so as to make the total amount of the curvature of space-time a minimum: or, as we may say, *gravitation simply represents a continual effort of the universe to straighten itself out.* This is general relativity in a single sentence. He then examines the Mach-Einstein doctrine that the metric of space-time is determined wholly by the masses and energy present in the universe, so that space-time cannot exist at all except in so far as it is due to the existence of matter. Finally, reference is made to the De Sitter world and the difficulty of estimating the radius of curvature of the universe.

Co-ordination Compounds.

Dr. N. V. Sidgwick points out in his presidential address to Section B (Chemistry), how the apparent contradiction between the principles of structural chemistry and the theory by which Werner accounted for the composition and properties of his co-ordination compounds was resolved by means of the electronic conception of valency. The co-ordinate link is clearly from its behaviour a form of covalency (non-ionised link), consisting in the sharing of a pair of electrons between the two linked atoms; but whereas in the normal covalency one of the two electrons is derived from each atom, and so the number of links formed depends on the periodic group to which the atom belongs, in the co-ordinate valency both electrons are derived from one atom, which removes this limitation, and the maximum covalency or co-ordination number is the number of pairs of electrons in the maximum valency group.

The formation of a co-ordinate link thus requires the presence (*a*) of an atom (the donor) with two unshared valency electrons to lend, and (*b*) of another atom (the acceptor) capable of taking them up. The link so formed is less stable than an ordinary covalency, owing to the greater stability of the products of its rupture, and it also communicates a dipole character to the molecule (the donor having something of a positive and the acceptor something of a negative charge), which leads to an increase in the dielectric constant and a diminution of the volatility. It is by the formation of these links that liquids become associated, and accordingly we always find in the molecule of an associated liquid a donor and an acceptor atom; in the commonest case of the hydroxyl group, the oxygen of course is the donor and the hydrogen the acceptor. This explains the anomalous position of such compounds as amines and ethers, which behave like associated liquids in some ways but not in others: they contain donors (the nitrogen or the oxygen) but no acceptors, and hence cannot associate with themselves or with non-associated substances, but can do so with associated substances, because the latter contain the requisite acceptor atoms.

The occurrence of co-ordination compounds is thus by no means confined to the Wernerian complexes, but is widely distributed throughout organic as well as inorganic chemistry. It is essential to recognise the importance of this factor in chemical reactions, especially in relation to the modern intensive study of reactivity in organic compounds. The unique position of carbon, on which the very existence of organic chemistry depends, can only be understood by reference to the theory of co-ordination: its inertness in its saturated compounds (to which the number and variety of these compounds is largely due) depends on the fact that the quadrivalent carbon atom, with a completely shared octet incapable of further expansion, can act neither as donor nor as acceptor.

The further development of our knowledge of the influence of co-ordination on reactivity involves in particular the investigation (1) of the effect of other atoms in the molecule on the tendency of an atom to exert its donor or acceptor properties—on its power of forming co-ordinate links—and (2) of the extent to which the formation of co-ordination compounds is an intermediate stage in chemical reactions.

Tertiary Volcanic Activity in Britain.

Dr. Herbert H. Thomas's presidential address to Section C (Geology) is concerned with the British Tertiary centres of intrusion, more particularly with the plutonic and hypabyssal rocks. Local subsidence is the chief factor in the determination of the sites of the major intrusions, which subsidence has allowed the uprise of magma from the great intercrustal basin that supplied the plateau-basalts. The ring-dyke and the stock are the dominant forms adopted by the main intrusive bodies and the two are closely related in origin. Laccolites in the true sense are practically unrepresented, as might be expected in regions that have been affected by tensional rather than compressional forces.

The sequence of events as established by recent

work in the respective centres, and the mutual relations of contiguous intrusive masses, are discussed. In unravelling the structure of an igneous complex, emphasis is laid on the importance of screens—those narrow masses of older rocks that completely or partially separate otherwise contiguous intrusions of ring-dyke type. As regards the origin of the various rock-types, the view is taken that they are all derived from a magma of basaltic composition by a process of differentiation which is primarily dependent on the separation of crystalline phases. In agreement with Dr. Harker, however, Dr. Thomas holds that the general order of intrusion, that is, from basic to acid, could not be maintained without the remelting of an already differentiated density-stratified, or completely solid magma. Contamination has played no appreciable part in modifying either the primary or subsequent magmas, and no variations of rock-type among the major intrusive bodies can be attributed to this cause.

Ancient History of Animals.

In his presidential address to Section D (Zoology), after discussing indications of a pre-Cambrian cataclysm, Dr. Bidder considers the conditions of originating life, and suggests that protein adds to itself rhythmically, alternately accumulating energy from the environment and expending it on the formation of a new molecule. This rhythm of energy would be accompanied by a rhythmical expansion and contraction of volume. Evolution of the flagellate consisted in the formation of a permanent filament of protoplasm characterised by having one side more gelated than the other side. Thus the rhythmic expansion in volume caused a rhythmic convexity of the more extensible side, followed by an elastic counterstroke at the moment of synthesis and contraction. The rhythm of storage of energy alternating with synthesis has never been lost, and is the foundation of our sense of time and of the phenomena of age and senile death.

The mucilaginous exudation of flagellates enables their longitudinal fission to produce sheets of coherent cells, often curved until they form closed 'hilospheres.' In such a closed sphere exudation cannot escape from the central cavity, so that if the cellular envelope be permeable, the tension of its walls and of its surface are opposed by the osmotic pressure of its contents. Should the cells of a hilosphere or blastosphere at any time withdraw salts, proteins, or sugars from the gelatinous interior, so as to make it hypotonic to the external water, water will pass out and invagination will take place.

In certain strains of flagellates the cells of the envelope, behaving as do Metazoan cells *in vitro*, proliferated cells into the internal jelly, which thus became capable of transformation into the inter-epithelial parenchym of cœlenterates and true sponges, the mesenchym of larvæ and the tissues of the higher Metazoa. This tendency is shown in Proterospongia, but is not usual in colonial choano-flagellates; and it is not shown in hexactinellid sponges, which must therefore be distinguished as *Porifera nuda* from the *Porifera vera* the collar-cells of which are based on jelly. The Clavulida, Desmacidonida, and Renierida show triaxon symmetry in their spicules (cf. Nature, Feb. 28, 1925, vol. 115, p. 298), and are probably descended from Hexactinellida. They may be grouped together (probably with the Axinellida) as the Orthogonida. The *Porifera vera* include Tetraxonida s.s., Ceratosa, and Calcarea; from these last the Enterozoa may be descended.

Sponges are multicellular organisms specially adapted to bring to each flagellate cell a number of minute organic particles suitable for intracellular digestion, and to exclude larger fragments. In no sponge can the sponge's current carry a body larger than a human blood-corpuscle into the flagellate chamber, and in most the entrance pores of the chambers will not admit a particle one-third of this diameter. Therefore sponges are older than Enterozoa, which are evolved to digest large fragments, and must have originated after there existed cellular aggregates large enough to require a stomach to attack them. If Enterozoa be descended from sponges, they may both still be united in the kingdom Animalia; if they are not so descended the sponges must be recognised as a third kingdom of multicellular organisms, the Microphaga, specialised for the intracellular digestion of living organisms less than 5μ in diameter.

Some Problems of Polar Geography.

Dr. R. N. Rudmose Brown, in his address to Section E (Geography), deals first with some problems in the physical geography of polar regions. The attainment of the poles has not put an end to the need for exploration, but has rather given an opportunity for work in the future being concentrated on specific problems. In the Antarctic, the two great problems are the discovery of the outline of the continent, the existence of which is still based on circumstantial evidence, and the elucidation of its structure and relations to the

other southern continents. The relationships of the contrasted structures of Victoria and Graham Lands are discussed at length. Further problems of importance awaiting solution are the peculiar Antarctic blizzards and the general circulation of air over the continent, especially with reference to the alimentation of the ice-sheet.

In Arctic regions there are no pioneer problems of equal magnitude, and though no extensive land is at all likely to be discovered, there is the possibility of several reports of islands having some foundation in fact. These are discussed in full. Of more importance is the oceanographical exploration of the Arctic basin and the explanation of its origin as an earth feature. The circulation of Arctic waters and the distribution and fluctuation in amount of ice discharged into the Atlantic are problems with a practical bearing on the weather of the British Isles.

In discussing the methods of exploration, Dr. Rudmose Brown sees little value in the aeroplane for the detailed scientific work that is now required in polar exploration, except in the survey of difficult country lying within easy reach of a base accessible by sea transport and provided with good landing places. Amundsen's daring flight across the Arctic Ocean had few important geographical results. In the Antarctic, where much pioneer work has still to be done, aeroplane flights may be of some value, but a forced landing would probably spell disaster.

The last part of the address is concerned with a discussion of the possibility of settlement and colonisation in Arctic lands. This entails an examination of Mr. V. Stefansson's glowing picture of the future of the Arctic prairies of Canada, and the fate of the old Norse colonies in Greenland. As pressure on the world's food resources becomes greater, pasture land in temperate lands will become scarce. Then the value of Arctic prairies for reindeer and musk-ox will be realised. Herein lies the probability of a gradual invasion by the white races of the outer rim of the Arctic as the native races of Siberia and northern Canada die out before the flowing tide of civilisation. Climate offers no real impediment to Arctic settlement.

Organisation in Industry.

Prof. D. H. Macgregor's address to Section F (Economic Science and Statistics) on "Rationalisation of Industry" consists of a review of the questions raised by the claims of highly organised industrial combinations to control and steady the evolution of industry. Attention is first directed to the change of opinion which has taken place in the post-War period as regards such combinations, which were regarded with much less favour before the War. The creation of such great structures as the 'European steel cartel' has reacted on the views held in each country, since national organisation is a condition of international agreements of this kind.

The conception of rationalisation is presented as one which makes in industry for the application of the idea of government, and of the leadership of those most qualified to govern. The 'cartel,' the 'trust,' and the 'concern' show different aspects of this conception. The idea of the government of an industry as a whole, as distinct from the less organised relations of competitive producers, is borrowed from political affairs; and the question how far it is applicable to the field of industry should be discussed by bringing also into the argument such other types of government as the ecclesiastical and the military.

Industry is not alone in not having been able to apply the political type of administration, the sphere of, for example, authority being greater in other non-political spheres than in industry. Some ideas are common to the conception of government anywhere, such as the completest range of control, and the control of what lies on each side of the main interest—and these appear in industry as the tendency toward monopoly, and toward the vertical union of successive stages of production. But the special conditions of the industrial sphere, private liability and risk, are unique.

The organisation of 'combines' shows that many advantages could follow in respect both of the technical evolution of capitalism, and its relation to labour. But what is most rational in the way of higher organisation in industry is to be found rather in a proper balance, something being sacrificed from the unity of a complete government on one hand, and on the other hand from the 'Ricardian rationalisation' which works out through the adjustment of success and failure. Industry is not to be subsumed simply under the conceptions of government which are valid elsewhere, but must find out what degree of unity in administration is consonant with its unique conditions.

Discovery and Invention.

Sir James B. Henderson, in his presidential address to Section G (Engineering), deals with "Invention as a Link in Scientific and Economic Progress." Discovery and invention are so closely allied that they are frequently confused, and in common speech the two words are often used synonymously. No clear distinction can be drawn between them except in such general terms as that discovery begins and ends as a mental conception forming an addition to man's abstract knowledge; while invention, although also a mental conception in its origin, is essentially material, inasmuch as it is a conception of some practical application of knowledge. Discovery and invention bear therefore towards each other more or less the same relation as exists between theory and practice, between the abstract and the concrete.

Both are alike, in that although possibly the result of an instantaneous flash of inspiration, or possibly of an accident, or it may be, the result of long and tedious study, great discoveries and great inventions can seldom be considered complete until much time and effort have been spent on their confirmation or development. This latter period of their history generally demands also the expenditure of large sums of money, so that we find in discovery, invention, and finance, a union of three factors allied in the service of man.

Invention, considered by itself as a link in progress, is a peculiar combination of an exact science, such as engineering, physics, or chemistry, with a historical science, like the science of war or of economics. The latter are studied as sciences, though based in no foundation of physical laws. The science of war is studied historically from records of the tactics, strategy, successes, or failures of old campaigns, such records being kept with meticulous care in official records for the benefit of the soldiers of to-day. But in the science of invention no such records exist, with the result that in the war between the inventor and Nature the same mistakes recur again and again, and many an invention fails from lack of any historical record or intelligence service such as guard the soldier against repetition of the mistakes committed by other generals of the past. In other words, the inventor starts from scratch, yet there must be, or must at some time have been, an enormous volume of technical knowledge which, were it only available, would aid greatly in the rapid development of his invention and would possibly turn some of the failures into successes. Is there no way to bring this accumulated knowledge to light? Much of it is necessarily lost because those who possessed it have died without leaving any record of their knowledge. But can we not start now to remedy this defect and to prevent its perpetuation?

Much could be done if science could be taught historically in our schools and colleges. Against this the great impediment is time. So much has already to be crowded into the short course of scientific study that no time is left for the study of the history of a science. Possibly something could be done by legislation through alteration of the Patent Acts to bring the history of an invention, with all its difficulties and their conquest, within the description of the invention published in the patent specification. This would necessitate discrimination between minor inventions which can be rapidly and easily developed, and the major inventions which form the milestones in scientific progress. The development of these cannot possibly be achieved, or the difficulties overcome, within the short period of nine months within which a supposedly complete description of the finished invention has to be filed. A third remedy lies in the hands of the British Association and other kindred bodies, to whom it is open to invite inventors to contribute a historical record of their inventions, whether successful or unsuccessful, and particularly a record of the difficulties which they encountered in the process of development. Such records, which could be published in the proceedings of the technical societies at a time selected by the authors, would furnish a nucleus of an invaluable library of a kind which does not exist to-day, and would be of incalculable assistance to the inventor and the scientific worker of the future.

The Englishman of the Future.

Prof. F. G. Parsons, in his presidential address to Section H (Anthropology), deals with the knowledge which he has gained of the way in which the Englishman has changed during the centuries; and, considering these changes, he suggests their probable effect in building up the Englishman of the future.

With regard to height, the well-nourished Englishman of to-day averages 5 ft. 9 in.; and, because he has done so steadily for the last twenty years, it is thought that this height is the limit which English males will reach. With English women, on the other hand, height seems to be increasing year by year, and there is no reason therefore to think that the present average of 5 ft. 5 in. for women of the well-nourished classes will not be passed by two or more inches. With regard to colour, when the statistics of to-day are contrasted with those left us by Dr. Beddoe, sixty years since, the present observer has to admit that he finds no sign of darkening of either hair or eye colour, but that, in every case, the change, though slight, is on the side of fairness. In these two factors of colour and height, therefore, there is reason to think that, so far from the Nordic characteristics of the English people disappearing, they seem to be increasing.

In dealing with head shape, it is important to take into account the head height as well as the cephalic index, which alone is not sufficient to indicate what is happening. The length, breadth, and height of the head can be expressed in terms of the sum of all three, and the variations of these ratios, from the earliest Neolithic times to those of the present day, can be demonstrated. One of the most striking facts brought out by this method is that during the last two centuries the English skull has been increasing very markedly in height, even in the poorly educated classes of the community; while in the more highly educated, which have been influenced most by modern hygiene, the increase is really startling, and the head height is much greater than that which any of the races from which the modern Englishman is derived can show. The inference is that environment, rather than heredity, is influencing the head shape, and that the Englishman of the future will have a head quite different in shape from that of any of the ancestral races from which he is descended. With the shape of the head, of course, that of the brain is changing too, and this cannot be without its effect upon the mental characteristics of the Englishman of the future.

The Development of Human Physiology.

The last fifty years have witnessed the great extension of the method of physiological investigation by means of direct experimentation on animals, a method which may be termed the analytical method since the organism is treated as a series of systems which, though but parts of a whole, are yet capable of being regarded within limits as independent. Valuable though this method has proved, and will continue to prove in the future, Dr. C. G. Douglas, in his presidential address to Section I (Physiology), points out that we must recognise that it has in

reality definite limitations, and if we are to understand life we must ultimately adopt methods of investigation which do not interfere with the normality of the organism or its natural powers of self-maintenance.

In the study of normal physiology, man is in many instances a more advantageous subject of investigation than are the lower animals, because we can ensure the maintenance of any degree or type of natural activity that we may desire, we can obtain the co-operation of the subject, and we can learn his subjective impressions. This claim can be justified by a review of the experimental work which has already been done on the human subject in many branches of physiology; for example, in the study of the general energy output under different conditions of normal activity, of the regulation of the respiration and circulation, of the function of the kidneys and of the alimentary canal, while we owe much in other fields to investigations undertaken primarily in the cause of clinical medicine. The outstanding contributions to knowledge which we owe to human physiology are the quantitative changes of organ activity associated with normal life, the close functional linkage of the different organs, and the power of adaptation to altered circumstances.

We have learnt something of what really characterises normal life, and we have been put in a better position to make use of the information obtained by the analytical method of investigation of the lower animals, which by itself affords, as a rule, evidence of potentialities rather than actualities.

The development of human physiology is already sufficient to justify greater prominence being given to this subject in our teaching of physiology, and this is especially true of practical courses of instruction. Many students only take a course of elementary physiology as a preliminary to the study of medicine, but it is not difficult to incorporate even in an elementary course simple experiments in human physiology which, by allowing the student to appreciate something of what happens in his own person in the course of everyday life, will awaken his interest and curiosity, and by giving him a guiding line of thought will help him to grasp more readily the significance of what he reads. Unless the student can gain some real conception of the way in which physiology is helping to elucidate the phenomena which characterise normal life, there is a risk that a gulf, for which there can be no justification, will deepen between physiology and medicine.

Mental Unity and Mental Dissociation.

It is significant that the problem of unity and dissociation occurs in many forms in current physical, physiological and psychological spheres. Even in psychology alone, various doctrines have caused controversies as to the answer to be given to the question: What is unitary and what is multiple? Thus the *Gestalt* psychologists stress the unity of a presentation or pattern. Another notable instance is the question of the purity of a 'general mental energy' as a mental content.

In abnormal psychology the problem presents a characteristic form. Dr. W. Brown, in his presidential address to Section J (Psychology), points out that Pierre Janet and Morton Prince in the hypnotic period of psycho-pathology developed the concept of mental dissociation, and a characteristic feature of this period is the frequency with which cases of multiple personality were discovered. Dissociation, for Janet, is the fundamental and all-important feature of neurotic disorders. It is true that in the writings of Freud and Jung the word 'dissociation' seldom occurs, its place being largely taken by the term 'repression.' But it is characteristic of Dr. Brown's view that both unity and dissociation are regarded as aspects of the normal mind; both are ultimate. In his latest book, "Mind and Personality," Dr. Brown points out that recent discussions of personality stress the multiplicity—"looking for unity as a result of interaction between the many instead of regarding the unity as something ultimate." He admits that the unity of the developed adult mind is to a great extent an acquired unity, but holds not only that ultimately we are multiple as well as unitary, but also that the feeling of unity is present at every moment of consciousness.

Lest such a view be regarded as an insignificant platitude, it may be noted that cases of multiple personality are no longer on record among the psycho-analysts of to-day, who have replaced hypnosis by deep analysis, or *autognosis* as Dr. Brown prefers to call it, the reason being that the hypnotic method tended to produce multiplicity, whereas autognosis is a process of unification. There is actual development of the mind going on during the process towards the normal and the unitary. Any dissociation that is encouraged by the method is a normal dissociation; any dissociation that is overcome is a pathological dissociation or repression, that is, a dissociation that is not complete or thoroughgoing.

In an attempt to interpret character and personality along these lines, Dr. Brown is therefore unable to accept McDougall's theory of the self as a system of monads which form a hierarchy, in which there is one dominant monad, the conscious self, and a number of subsidiary monads that are, in a normal mind, adequately subordinated to the chief monad and are in relation to the chief monad through telepathy; but in a case of multiple personality, one of these subsidiary monads may break loose and become insubordinate. On such highly hypothetical matters differences of opinion are inevitable. In many respects, however, Dr. Brown is in agreement with McDougall. It need scarcely be said that both hold that a biology which neglects psychology is incomplete, as the unity of the organism becomes more intelligible when we think of it as a mental, and in part, a conscious, unity. The ultimate factor is a purposive general striving, which must be assumed in order to account for the theory of conditioned reflexes.

Early Beginnings of Plant Life.

Prof. F. E. Fritsch's address to Section K (Botany) deals with "Some Aspects of the Present-Day Investigation of Protophyta." A study of the simpler Algæ and holophytic Flagellata is of first importance, since they afford the only material upon which we can base views of the early beginnings of plant-life and the mode of origin of the plant-body. The modern outlook with respect to these organisms dates from the distinction some thirty years back of the Green (Isokontæ) and Yellow-green Algæ (Heterokontæ), as phyla originating from separate flagellate ancestries. The two classes differ in certain morphological features, but more fundamentally in physiological characteristics (plastid-pigments, products of photosynthesis, etc.). On the same basis nine further classes of pigmented Protophyta are recognisable, representing as many evolutionary lines. The old distinction between Algæ and Flagellata is no longer tenable, since various classes of the latter (Chrysomonadineæ, Peridinieæ, Cryptomonadineæ) have been shown to possess true algal representatives. It is probable that each series of holophytic Flagellata might have advanced to algal organisation, although some (Euglenineæ, Chloromonadineæ) have apparently failed to do so. The acquisition of algal characteristics (cell-wall, sexuality, etc.) has ensued at different levels in the different classes; thus, in the Heterokontæ and Chrysophyceæ the motile unicells and the palmelloid types are Flagellates, whilst in the Isokontæ the same forms are prevalently algal.

There is evident a far-going parallelism (homoplasy) between the classes of pigmented Protophyta. The same types of construction (unicellular, colonial, filamentous) recur repeatedly and are in part represented by astonishingly similar forms. Evolution has clearly progressed along analogous lines in each class and, except in four (Bacillariales, Cryptophyceæ, Euglenineæ, Chloromonadineæ), has culminated in the branched filament. The highest Isokontæ (Chætophorales) possess a plant-body differentiated into a system of prostrate threads and a branched projecting system. The same type of thallus is found in the simplest brown and red seaweeds, most of which are nevertheless far more elaborate. The green Algæ thus terminate blindly at the level at which the two great marine phyla commence.

In view, however, of the extreme capacity for morphological elaboration and for adaptation to very diverse habitats (including terrestrial ones) shown by the Isokontæ, a failure to develop further in the direction generally indicated by the Phæophyceæ and Rhodophyceæ is inconceivable; moreover, their photosynthetic equipment is that characteristic of land-plants. This implies that, approximately at the level of morphological differentiation and stature reached by the Isokontæ, the terrestrial habit was adopted and that the more advanced green Algæ have been lost because they became land-plants. The many analogies that can be traced between Phæophyceæ and Rhodophyceæ on one hand, and land-plants on the other, are to be regarded as a natural outcome of the general evolutionary trend in the vegetable kingdom. As regards the alternating generations, so characteristic of land-plants, the evidence for or against their occurrence in the higher green Algæ is at present quite inadequate, and parallel cases to that of Pylaiella among the Ectocarpales are perhaps yet to be found in the Chætophorales.

The address concludes with remarks on the methods of investigation of the simpler Algæ. The limitations of pure cultures are discussed and a direct periodic study, especially of the filamentous types, advocated. Attention is directed to the extremely backward position of Great Britain as regards fresh water biological stations and the urgent need for the establishment of a well-staffed and properly equipped station on the Norfolk Broads emphasised.

Broadening the Educational Outlook.

In her presidential address to Section L (Educational Science), the Duchess of Atholl deals with the point emphasised in the recent Report of the Board of Education's Consultative Committee on the Education of the Adolescent, that the wide variations of capacities and gifts among the large number of children in the schools can only be met by a wide variety of courses of instruction.

After briefly reviewing the broadening of the curriculum, both in school and university, since the Middle Ages, she points out that it is only within the last twenty or thirty years that there has been established a fairly balanced secondary curriculum in literary and scientific subjects, and that it is not surprising, therefore, that the progress of handwork as an instrument of education has been slow. But handwork, with its appeal to the child's creative interests, can be equally helpful in laying the foundations of cultural development and may claim quite as much 'intellectual respectability' as reading, writing, and arithmetic.

So far as secondary schools are concerned, it was only in 1912 that the Consultative Committee recommended that every secondary school should provide for the teaching of some branch of educational handwork. As regards elementary schools, the same Committee reported in 1905 in favour of schools which would combine a general education with some practical instruction in a course extending up to 15 years of age, while the Education Act of 1918 has made it obligatory on education authorities to provide practical and advanced instruction for older scholars either in central schools and classes or otherwise.

Although the need for a wider curriculum, including practical work, has thus clearly been recognised, the present position can scarcely be regarded as satisfactory. There is still too great a tendency to pass on as many children as possible to the ordinary secondary school where the curriculum, however well adapted for boys and girls of scholastic ability, may be quite unsuited to pupils of another type, leaving school at about 14 or 15

years of age. The reasons for the neglect of practical training have been various, but principally there has been a failure to appreciate the psychological issues involved. Practical work is one way of securing the interest of the child, and there can be no intellectual development without interest and understanding. This truth does not merely apply to the younger children, as recent psychological tests have shown that the need for the variety of curriculum increases with adolescence. Practical instruction is not merely desirable for the dull and backward, in whose case its worth is generally recognised; it is necessary for those children who have a non-verbal or practical ability which may be quite equal to the normal and yet fail to show itself in the ordinary lessons of school. By providing an outlet for this practical ability, confidence is gained which reacts with good results on the ordinary school work.

Further, it is important to remember that practical instruction is an element in character training, tapping fresh sources of energy and forming a wholesome corrective for the 'overbookish.' On educational grounds alone, therefore, at the post-primary stage there is need for the greatest variety of courses and for courses including practical instruction.

Such instruction is also required from the point of view of social and economic welfare. Practical training will engender adaptability and will produce boys and girls who will not regard the clerical occupations as the only avenue open to them, but will be ready to take their place in industry and will have the initiative to avail themselves of the opportunities offered by our Empire overseas. It will further assist in that important part of education—training for leisure; while, in so far as handwork is often co-operative, it will reinforce that training in the team spirit which is inculcated through school games and school life generally.

The most important task of education in the immediate future is to develop new forms of post-primary instruction which shall not be a mere imitation or rival of the ordinary secondary school, but will offer to every child a chance of developing its special ability as well as of acquiring general culture. Many difficulties have to be faced—among them being a shortage of handicraft teachers—but if this aim can be kept clearly in view, progress will be sure, and we shall be able so to frame our system of education as to bring to the service of the community in its varying needs rich contributions of equally varied ability.

Agriculture and National Education.

Several aspects of agriculture in its relation to education are discussed in Mr. C. G. T. Morison's presidential address to Section M (Agriculture). He deals first with the provision of technical and vocational training in agriculture, he points out that no system can be regarded as complete which fails to make provision for the instruction of all three partners in the industry; no system can be regarded as satisfactory which is not more completely utilised than the present. While the provision of technical education for the landlord and the farmer has been satisfactorily developed, the manual worker, upon whose skill the economic efficiency of the business more than ever depends, finds little or no opportunity for training.

It is suggested that one reason for the failure of technical education and research to produce its full effect upon the agricultural industry lies in the fact that many farmers and all manual workers inevitably cease their general education too early. To obviate this it would be necessary to ensure that something in the nature of general education of university type should be available throughout the country districts, so that cultural education, apart from vocational training, could be continued to a much later age than at present. It is held that, before it is possible to make a fuller use of the technical instruction which is, or can be, provided, it is necessary to arouse the desire for it; for this it is necessary to create and maintain a more receptive mind.

The present unsatisfactory condition of the agricultural industry demands some definite policy, and this can only be achieved if there is a greater understanding of the needs of agriculture by the whole population, urban as well as rural. Justification for this widening of agricultural education is to be found in the fundamental importance to the nation of a flourishing agriculture. In the opinion of certain authorities, the day is not far off when not only Great Britain but also countries hitherto food-exporting will have to consider the framing of a definite national agricultural policy in the interests of the whole population. If Sir Daniel Hall and those who think with him are right, the time will shortly come when the demands of an increasing population will make intensification of production inevitable. That continued scientific investigation is necessary in order to produce this result will only be realised by that nation which includes some knowledge of agriculture and food production in the national education of its citizens.

It should be possible by broadening the basis of scientific education to bring it more into touch with the realities of life. This could be achieved by developing, from the most elementary nature study, a conception of scientific training which would meet all the requirements of the ordinary man, and would enable him to have a reasoned and informed opinion about the most fundamental of all industries, and the various problems of the food supplies of the modern world. As a purely educational and non-vocational study, agriculture is a suitable university subject if it be not confined, as hitherto, almost entirely to the side of physical science, but developed to include a study of current agricultural conditions throughout the world, and of economic science in its application to agriculture. The world situation to-day demands more information on this subject among educated men; the precarious position of the industry in Great Britain demands a sympathetic understanding. Both of these demands can only be met by fuller education.

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Our Bookshelf.

Cultural and Anthropological Studies.

Life and Work in Medieval Europe (Fifth to Fifteenth Centuries). By Prof. P. Boissonnade. Translated, with an Introduction, by Dr. Eileen Power. (The History of Civilisation Series.) Pp. xix + 395 + 8 plates. (London: Kegan Paul and Co., Ltd.; New York: Alfred A. Knopf, 1927.) 16*s*. net.

Miss Eileen Power has introduced to us in an admirable translation a very important French book on the Middle Ages. Prof. Boissonnade may be thought to have exaggerated the good effects of the Roman Empire, and of its later successors for a thousand years in the East, and he may be said to have put too low the character of the invading barbarians and too high their devastating results. These are the sides on which his book is open to criticism and may need some modification. But he must be held to have made good his main contention that in the late Middle Ages, from the eleventh to the fourteenth century, a work of economic and social development was accomplished in the West on which all later progress has been based, and which has hitherto not received the attention it deserves owing to the preoccupation of historians, on one hand, with the fighting which went on sporadically but continuously throughout, and, on the other, with the religious evolution which, on any showing, is the most characteristic and central fact. But in the new setting which Prof. Boissonnade gives us, the Church will find no cause to complain, for the religious houses, especially of the monastic orders, easily take the first place in the work of cultivating the soil, reclaiming waste places, encouraging labour and employing craftsmen of all kinds in the earlier dark period before the workman found his own place in the social order and claimed freedom and power.

It is this process of industrial emancipation which fills the second part of the essay, and shows how similar and continuous the upward movement has been ever since the barbarians settled down within the framework of the old Roman Empire. First, the colonisation of the soil, then the spread of craftsmanship and commerce, then the incorporation of the workers of all grades; this was the order of events, and they have never been so clearly exhibited, with such a wealth of learning, appropriately introduced and illustrated, as in this book. F. S. Marvin.

The Anglo-Saxons in England during the Early Centuries after the Invasion. By Nils Åberg. (Published with aid of Grants from Vilhelm Ekmans Universitetsfond, Längmans Kulturfond, and the Swedish Government.) Pp. viii + 219. (Cambridge: W. Heffer and Sons, Ltd.; Uppsala: Almquist and Wiksells Boktr. A.B.; Haag: Martinus Nijhoff; Leipzig: Otto Harrassowitz, 1926.) 12*s*. 6*d*. net.

Prof. Åberg's valuable analysis of Saxon style does not profess to be in any sense a complete survey of Anglo-Saxon art. It is an attempt to work out a chronology on the basis of the archæological (typological) evidence, testing it, however, when possible, by the known facts of history. In any such analysis, Kent, as any one acquainted with the material is bound to realise, takes a prominent place. Prof. Åberg is of the opinion, however, that the undoubtedly distinctive position taken by Kentish culture is not to be attributed so much to race as might be thought if Bede's statement that the invaders of Kent, the Isle of Wight, and parts of Hampshire, were Jutes, were accepted as indicating some real racial distinction. He is rather of the opinion that social conditions favoured a greater unity there which led to a great commercial expansion. This would have admitted of continental influence in the latter part of the sixth century under Ethelbert, when there was a quickening of Germanic culture in central Europe after the irruptions of the Lombards into Italy and their penetration to the Mediterranean. It is at any rate significant that it is only after the first century succeeding the invasion of Britain that the differentiation of Kent from the rest of England and its marked superiority in artistic effort became apparent.

Prof. Åberg's proofs for this and the subsequent chronology, both for Kent and the rest of England, are worked out in great detail in relation to continental evidence. The case is well argued, though perhaps open to question on points of detail. The isolation of Sussex, for example, surely requires the intervention of no racial or social factor, but is explicable on purely geographical lines.

Population Problems of the Pacific. By S. H. Roberts. Pp. xx + 411. (London: George Routledge and Sons, Ltd., 1927.) 21*s*. net.

While it is generally admitted that the contact of the backward races with the European civilisation has generally proved detrimental to the former,

opinions differ as to whether their ultimate extinction, with possibly a few exceptions, is inevitable. The arguments for and against are inconclusive, because generally based upon an imperfect knowledge of facts.

Mr. Roberts's survey of the problem as it has arisen in the Pacific, where it is perhaps more serious than in any other area, does at least attempt to give an impartial account of the conditions and to provide the data upon which to base a conclusion, so far as these are ascertainable. In fact, his book might very well be regarded as a handbook to the ethnology, history, vital statistics, and economic conditions of the native populations of the southern Pacific of to-day. His study of the inhabitants of the islands in their early contact with Europeans, travellers, missionaries, and traders, is particularly important in this connexion, because in evaluating its effect, he is scrupulously fair in giving full weight to the facts which tell on either side. Especially does he accord recognition to the beneficial as well as the detrimental elements in missionary interference with native custom. The former are often overlooked in this connexion. On the other hand, there is also a tendency just now for the pendulum to swing in the opposite direction of asserting that the decline in the numbers of the native populations had already been set up in pre-European days. With this view Mr. Roberts, without minimising the ill effects of the white intrusion, is inclined to agree, attributing it to certain social customs, such as infanticide, a lax morality, and the influence of an enervating environment on races previously accustomed to more strenuous conditions.

Whether this view be correct or no, so far as regards the present and the future, Mr. Roberts's book is a cheerful corrective of undue pessimism. The facts as he sets them forth suggest that if the period of decline is over and the apparent increase in the population can be maintained, while a reasonably enlightened policy is followed in administration, the position is by no means so hopeless as has been thought.

An Introduction to Anthropology. By Prof. W. D. Wallis. (Harper's Social Science Series.) Pp. xvi+520. (London and New York: Harper and Bros., 1927.) 16*s.* net.

Those whose duty or privilege it may be to advise intending students in anthropology, will welcome Mr. Wallis's endeavour to provide a comprehensive introduction to the science. For, as he points out, nothing of the kind has been attempted since Tylor wrote his little text-book "Anthropology." Something of this kind was badly needed. Although there are many admirable works which serve as introductions to some special branches of the science, other branches have been sadly neglected. Further, since Tylor's day much fresh evidence has accumulated, new methods of treatment of the material have been introduced, and although the main principles remain unshaken, controversy has raged and continues to rage around certain storm centres. It is essential that the student should be acquainted with the arguments pro and con, even if only for the training of his critical faculty. In the present book Prof. Wallis covers the main branches of the science—physical anthropology, archæology, the economic and industrial activities of man, science, magic and religion and social morphology—aiming at establishing principles and proving facts. For the most part theoretical reconstructions have been avoided. His treatment is both judicial and critical.

The Evolution of Man. Essays by Prof. G. Elliot Smith. Second edition. Pp. xii+195. (London: Oxford University Press, 1927.) 12*s.* 6*d.* net.

Only two years have elapsed since the publication of Prof. Elliot Smith's collection of essays on the evolution of man, yet in that brief period much fresh information has accumulated and much discussion of the evidence has taken place. Although in main outline the book remains unchanged, a certain amount of matter, notably that dealing with the cultural evidence, has been excised. The Taungs ape and the Piltdown skull in particular are discussed at some length, in the case of the latter especially with reference to the reconstruction of the brain case, a matter of special importance in view of the supposed discrepancy between the jaw and the rest of the skull. The London skull found on the site of Lloyd's building is made the occasion for a suggestive discussion of the occurrence of left-handedness in man and the ape in the light of the evidence afforded by the asymmetry of the brain.

Folklore and Religion.

This Believing World: a Simple Account of the Great Religions of Mankind. By Lewis Browne. Pp. 347. (London: Ernest Benn, Ltd., 1927.) 7*s.* 6*d.* net.

It may be thought doubtful if a book of this sort does much good. It is on the lines of Mr. Van Loon's short "History of Mankind," with weird, but sometimes suggestive, drawings by the author. A gaunt head of the old Celtic nature-goddess rising again as the St. Bridget of the Catholics, may be taken as a sample of the illustrations. It will at once outrage two large classes of readers who may chance to look at it, the more or less orthodox Christians who would be repelled by quiet putting of Christ on the same footing as Buddha, Zoroaster, and the rest, and the serious student who really wants to know the authority for all the statements, many of them startling enough, which are hurled at him in breathless and often broken sentences. Yet if one has overcome these obstacles and submits to be carried away by the author's rushing style through nearly 350 pages, one may certainly learn, or have revived in one's mind, vivid pictures of the early religious founders and of the superstitions which they met with and sometimes created after them. The author is at his best in the summary of Indian and Chinese religion and the stress he lays on Zoroaster. The passages on the influence

of Zoroastrianism on other religions and the witness that the Parsees of Bombay are now left to pay to the ancient faith, are true and striking. The general argument is towards evolution and not special revelations, and the book may be strongly recommended to large sections of the public in the United States, the land from which it springs. F. S. M.

The Darvishes: or Oriental Spiritualism. By J. P. Brown. Edited, with Introduction and Notes, by H. A. Rose. Pp. xxiii + 496. (London: Oxford University Press, 1927.) 18*s.* net.

Mr. H. A. Rose has carried out the task of editing this re-issue of Brown's valuable work on the Dervishes with commendable discretion. The object has been to make the mass of information which the treatise contains more readily accessible to the student of religions and mysticism. While retaining Brown's notes, he has supplemented them from his own wide knowledge of Islam. It has been suggested by eminent critics that Brown should be read with caution, but the present editor finds that as a result of his own researches the scholarly accuracy of the work has been confirmed. Brown, in dealing with the spiritualism of the Dervishes, not only had access to Turkish, Arabic, and Persian manuscripts, but also had the advantage of assistance from personal friends, themselves members of various orders in Constantinople in the middle of the last century. He himself had a high opinion of these orders, notwithstanding the unfavourable opinion expressed by many—an opinion which, however, it may be said in passing, still obtains to some extent. The editor in his introduction attempts an evaluation of the extent and character of their influence in Turkish history. In providing the material for this side of the study of the polity of Islam, Brown holds, and is likely to continue to hold, the field.

By Cheyenne Campfires. By G. B. Grinnell. Pp. xviii + 305 + 8 plates. (New Haven, Conn.: Yale University Press; London: Oxford University Press, 1926.) 18*s.* net.

"By Cheyenne Campfires" is a collection of the oral tradition of the Cheyenne Indians, which Mr. Grinnell himself has arranged in various categories—war stories, stories of mystery, hero myths, culture hero stories, and so on. Although their nature is to some extent indicated by this classification, the stories have a closer hold on reality than is usual in most mythological or traditional lore. In many cases the legends are historical and relate to real persons and actual events which took place at the beginning of the last century. Even the earliest stories, which relate to the times long before the Cheyenne reached the Missouri or passed on to the Black Hills, and depict culture elements of which the origin is now forgotten, have this effect of realism.

The Cheyenne represent an amalgamation of two tribes or peoples and consequently have two culture heroes. The sacred objects of the tribe are also double—they have both the medicine arrows and the buffalo hat. This volume is in a sense an appendix to an earlier book on the Cheyenne by the same author; but although a knowledge of that work is an advantage for the full understanding of this one, the stories carry their own atmosphere and are adequately supplemented where necessary by the author's comments and explanatory notes.

Folk Beliefs of the Southern Negro. By Prof. N. N. Puckett. Pp. xvi + 644 + 9 plates. (Chapel Hill, N.C.: University of North Carolina Press; London: Oxford University Press, 1926.) 22*s.* 6*d.* net.

It is not surprising that Dr. Puckett should feel justified in saying, "Regarding the feelings, emotions, and the spiritual life of the negro, the average white man knows little." The mentality of the negro of the southern United States is the highly complex product of a variety of heterogeneous elements. To a large extent his original African culture has been replaced by fragments of European civilisation, especially in the practical affairs of life. His folklore and religion are also European to a great extent; but not entirely, for much in this province, as it had no bearing upon his efficiency as a slave, remained purely African. It can, however, only be said to be African in a generalised form, owing to the fact that the negroes were drawn from numerous West African tribes and no one group remained in isolation after reaching its destination.

Dr. Puckett has an intimate knowledge of the negro, with whom he has been in close association for many years. He has also practised as an amateur hoodoo man. As a result his interesting chapters on the obscure voodoo practises not only summarise the records of others, but also contain much valuable information gathered at first hand. Dr. Puckett has produced a fascinating and valuable book.

History and Biography.

Ancient Egyptian Metallurgy. By Major H. Garland and Prof. C. O. Bannister. Pp. xi + 214. (London: Charles Griffin and Co., Ltd., 1927.) 12*s.* 6*d.* net.

The late Major Garland, on account of his official position in Cairo, had exceptional opportunities for studying the metals used by the ancient Egyptians, and this small volume has been arranged from his notes. A full and valuable account of the copper and bronze objects is given, and light is thrown on the methods employed by the ancient craftsmen for the making of castings and the building up of vases and similar objects. More analyses would have been welcome, as they are of particular value in tracing the origin of metal castings and forgings by comparison with analyses of ores from different districts.

An interesting section deals with the metallography of bronzes, from which it is seen that deliberate annealing was not carried out, whilst the methods of production were entirely similar to

those of the present day, allowing for the small scale of the operations. As regards iron objects, the author takes the view, held by many metallurgists against the opinion of archæologists, that iron was known at a much earlier period than is usually supposed, and that the tools of that metal have disappeared by oxidation. Whilst a strong case is made out for the use of steel tools for the carving of hieroglyphics in hard stones, the author has overlooked the evidence for the view that such early iron tools were made of meteoric iron found at the surface of the earth and forged without smelting. Mr. Zimmer has collected facts which seem to be convincing, and if this be the true explanation, then the use of iron at an early date was sporadic, and did not constitute an Iron Age preceding or contemporary with the Bronze Age. The two bodies of evidence should be considered together. Some of the photomicrographs are rather poor, but the remaining illustrations are good and instructive. The book is a useful contribution to a subject which is arousing much interest at the present time.

The Early Years of the Ordnance Survey. By Colonel Sir Charles Close. (Reprinted from the *Royal Engineers' Journal.*) Pp. iv + 157 + 16 plates. (Chatham: Institution of Royal Engineers, 1926.) 6*s*.

Sir Charles Close gives an interesting record in this book of the first hundred years of survey work in the British Isles, going back to 1746, when the campaign against Prince Charles first directed attention to the need of accurate maps. Watson's map of the Highlands was, however, little more than a compass sketch, in which roads and streams were traced and mountains put in by eye. The Ordnance Survey was not officially founded until 1791, and the first Ordnance map, on a scale of one inch to a mile, was not published until 1795. From then onwards rapid progress was made with the survey of England and Wales, Ireland and, later, Scotland.

In writing this history, Sir Charles Close has had access to much unpublished material, particularly a collection of letters and documents made by Major-General Thomas Colby, who was Director of the Survey from 1820 until 1846; and the pages are enlivened with numerous extracts from correspondence which throw much light on the difficulties that had to be faced in the foundation and early days of the Survey. The book is illustrated with reproductions of early maps and portraits of directors. It is a valuable contribution to the history of science in Great Britain.

The Interpreter: Geddes, the Man and his Gospel. By Amelia Defries. Pp. xiii + 334 + 9 plates. (London: George Routledge and Sons, Ltd., 1927.) 10*s*. 6*d*. net.

Patrick Geddes is a figure apart in our modern scientific movement. The paths of detailed research have not attracted him, but he has sought in all ways to develop an optimistic vision of the world in harmony with the opinions of science, and he has interpreted bits of that vision in such a way as to become in a very real sense the father of modern geography, of modern civic studies, and of a great deal of modern sociology, and of much that is hopeful in modern education, while his vision of the nature and associations of sex in evolution is penetrating into many minds.

Geddes has described himself as the boy who pulls the bell and runs away, and this is in a measure true, because he is always seeking the whole vision and careful not to let himself be engrossed in some detail of it. Miss Defries has done a service to many scientific workers by her collection of the graphs and schemes of notation that Geddes so persistently scribbles on scraps of paper. We only fear that they need Geddes himself to interpret them. There is a warm and serious appreciation of Geddes by Israel Zangwill and Prof. J. Arthur Thomson, and Prof. Patrick Abercrombie. Mr. H. V. Lanchester and Sir Chimanlal Setalvad contribute supplements. It is unfortunate that the scientific world can bestow no honour that would quite fit the case of Geddes, though its debt to him is seen in the manifold utilisation and development of his thought, not seldom by workers who scarcely know his name.

Old Chemistries. By Edgar F. Smith. Pp. xi + 89 + 31 plates. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1927.) 12*s*. 6*d*. net.

The author of this volume has made a collection of early works on chemistry that found their way to America, or were produced there, a century or more ago. He has written a narrative, linking together a copious collection of extracts, illustrations, and portraits, in the hope of interesting his fellow-countrymen in the historical aspects of chemistry. The volume which he has produced is therefore of the nature of an illustrated guide to his collection of books, rather than an independent review of an interesting period in the history of chemistry; but its publication may be welcomed as evidence of a growing appreciation amongst American chemists of the importance of a first-hand knowledge of the writings of pioneer workers in their science on both sides of the Atlantic.

Natural History.

Die Tierwelt der Nord- und Ostsee. Herausgegeben von G. Grimpe und E. Wagler. Lieferung 6 (Teil 10.e_1, 10.h_1, 10.h_2, 12.g_2). Teil 10.e_1: *Epicaridea*, von F. Nierstrasz und G. A. Brender à Brandis; Teil 10.h_1: *Stomatopoda*, von H. Balss; Teil 10.h_2: *Decapoda*, von H. Balss; Teil 12.g_2: *Teleostei Physoclisti*, 6. *Gadiformes*, von W. Schnakenbeck. Pp. 56 + 8 + 112 + 45-88. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1926.) 16·80 gold marks.

The present part of "Die Tierwelt der Nord- und Ostsee" includes four divisions—three in the Crustacea, Epicaridea, Stomatopoda, Decapoda, and Gadiformes in the Teleostei. It is a most useful work,

purposing to give a brief and up-to-date illustrated account of the whole fauna of the North Sea and Baltic. Not only is each animal described and figured, but also attention is given to its biology in the widest sense. In the section Epicaridea there are full notes on the mode of life of these interesting isopods, in many cases involving more than one host besides a free swimming stage. H. Balss is answerable for both the Stomatopoda and the Decapoda, the first being exceedingly brief but very much to the point; the second, the largest portion of this part, occupying 112 pages. However, to fit in descriptions of the whole of the decapod fauna of these regions into so small a space is by no means an easy task, and although every species is well described, the accounts of their larval stages are rather scanty. Thus the Brachyura are said to hatch as zoea, and there is no mention of the pre-zoea bearing the embryonic cuticle which is present in nearly all crabs, and in most cases moves in the water for a considerable time after hatching before liberating the true zoea.

The gadoid fishes, by W. Schnakenbeck, are well differentiated with good outline drawings. Here again the space allotted to larval forms is small, and the reader is referred to "Nordisches Plankton" for further information.

All the sections are fully illustrated with excellent line drawings taken chiefly from the various authorities quoted; the whole work forms a most valuable book of reference.

An Illustrated Key to the Identification of the Anopheline Larvæ of India, Ceylon and Malaya, West of Wallace's Line; with Practical Notes on their Collection. By Prof. C. Strickland and K. L. Choudhury. With a Foreword by Sir Ronald Ross. Pp. xi + 67. (Calcutta and Simla: Thacker, Spink and Co., 1927.) 4.8 rupees.

CHAPTERS on the collection, registration, and care of the larvæ are followed by a useful key. The features used in diagnosis are first carefully explained in the text with the help of a good diagram of an anopheline larva. For the purposes of the key the author follows Christophers in dividing anophelines into three series—protoanophelines corresponding to the subgenus Anopheles, deuteranophelines corresponding to the subgenus Myzomyia (part) of Christophers, and neanophelines corresponding to Myzomyia (part). By means of tables on one page and corresponding diagrams on the opposite page, the characters of the respective larvæ are set forth, and it should be a comparatively simple matter, at least in the great majority of cases, to identify the species of any given larva with the aids here provided. The characters of the clypeal hairs and of the palmate hairs are chiefly employed, but reference is made to antennal hairs and a few other features when necessary. The primary object of the authors has been to provide data so that larvæ collected can be determined at once without waiting for their development into adults. There is not only the saving of time in this method, but also a great saving of material, for a considerable loss by death takes place during the period of development.

British Ants: their Life-History and Classification. By H. St. J. K. Donisthorpe. Second edition, revised and enlarged. Pp. xvi + 436 + 18 plates. (London: George Routledge and Sons, Ltd., 1927.) 25*s.* net.

MORE than eleven years have elapsed since the first appearance of this book, and the demand for a second edition is testimony to its excellence. The study of ants has made considerable progress during this interval, and many important memoirs, together with several books, have been published. Since the first edition appeared, the ant *Myrmica schencki* Emery has been discovered to be a member of the British fauna, and another species, *Acanthomyops brunneus* Latr., previously included as an introduced insect, is now placed on the permanent list. As the author remarks, little has been added to our knowledge of the local distribution of British ants, and records of even common species are wanting from districts where they presumably occur. The substance and arrangement of the book are unaltered, but new information has been added wherever necessary, making the volume larger than its predecessor by 63 pages. There is little doubt that this standard work will meet with wide appreciation, and we look forward to the author's promised book dealing in detail with the structure and habits of the myrmecophilous fauna of Britain.

The Cestodes of Mammals. By Prof. F. J. Meggitt. Pp. iii + 282. (London: Edward Goldston, n.d.) 6*s.* net.

THE author prepared the basis of this work in the first instance for his own use, as he had experienced the handicap due to the lack of a comprehensive systematic manual of this kind. "To enable the average zoologist to identify the genus of any Cestode he may find," keys are provided to the subclasses, orders, families, and genera, and a separate key is added to the genera of larval forms. Under each genus is given a short diagnosis and the name of the type species, including its author and date. At the end of the work is a list of hosts, and under each host are noted the cestodes which have been recorded from it. An index to the generic and specific names of Cestoda included in the work, an index to hosts, and a list (22 pages) of the principal memoirs on Cestoda complete the volume. The last published works referred to are those of 1922, and the volume appears to have been printed in 1924 but has only recently been placed on sale. Since the MS. left the author's hands, Ejsmont has shown that Sanguinicola—formerly and in this volume regarded as a cestode and forming the sub-class Rhynchostomida—is a trematode. The manual is carefully prepared and will be found useful by helminthologists, and by teachers and senior students of zoology who desire to determine cestodes which they find in the course of examination of mammals.

Aspects of Biology.

Gifttiere und ihre Giftigkeit. Von Prof. Dr. E. N. Pawlowsky. Pp. xvi+516. (Jena: Gustav Fischer, 1927.) 27 gold marks.

One of the most curious problems of biology is to discover how certain creatures have developed the power of inflicting lethal injuries upon other animals not nearly related to themselves, and in some cases not directly helping their struggle for existence. But quite apart from the theoretical interests involved in the attempt to solve these conundrums, poisons and poisonous beasts have always had a strange fascination, if for no other reason because it has ever been a matter of vital importance not only to man but also to all living creatures to avoid the perils that lurk everywhere.

Although a vast amount has been written on the various aspects of the problems of poisonous animals—the bibliographies in this book amount to many hundreds of titles, snake-bite alone claiming more than 350—no really comprehensive treatise has hitherto been written on the subject. Now Prof. Pawlowsky of Leningrad provides us with an encyclopædia dealing with the anatomy and physiology of poisonous animals ranging from protozoa to mammalia, which displays an exceptionally wide range of knowledge, not merely of systematic zoology and cytology, but also of chemistry and pharmacology, of pathological anatomy and clinical medicine, of immunology and cultural anthropology. The book is a very remarkable achievement: it presents so much of varied interest that within the scope of a review it is not possible even to enumerate its virtues. There are 176 excellent illustrations. The book is likely to become a standard work of reference on every aspect of the poisonous possibilities of living creatures.

G. Elliot Smith.

Tabulae Biologicae. Herausgegeben von C. Oppenheimer und L. Pincussen. Band 4: *Chromosomen-Zahlen; Vererbungs-Lehre; Entwicklungs-Mechanik; Mastien, Tropismen, Taxien; Vital-Färbung; Gesichts-Empfindungen (Schluss); Constanten des Meerwassers; Sach-Register für Bände* 1-4. Pp. vi+829+7 Tafeln. (Berlin: W. Junk, 1927.) 4 vols., £12: 10*s*.

The first and second sections of this volume contain tables of the chromosome numbers of plants and animals. Reference is made easy by systematic arrangement of the genera. It so happens that for the three examples cited under the Culicidæ (mosquitoes)—Anopheles, Culex, and Theobaldia—the diploid number is six and the haploid three. The authors have omitted mention of *Stegomyia fasciata*, in which the diploid number is four and the haploid two. The section on heredity gives data and formulæ on variation, correlation, mendelism, crossing, heredity in man (*e.g.* of disease and abnormalities).

The part on developmental mechanics deals with embryogeny, regeneration, growth, and the effects thereon of thyroid and other extracts. The following section summarises the known effects of contact, flowing water, air currents, gravitation, heat, moisture, light, electrical and chemical stimuli. A short section follows on the colour sense of animals. Protoplasmic movement, contractile vacuoles and vital staining receive adequate treatment, and there is an extensive concluding section on sea water from the physical, chemical, and biological point of view. An excellent subject-index to the four volumes occupies 209 pages.

This volume and its three predecessors contain a great mass of carefully checked and organised data and formulæ relating to all branches of biology from which can at once be obtained the exact basis, so far as it is known, for the consideration of vital phenomena. References to the original sources are given, so that the reader knows where to obtain further details when necessary.

The editors and the ninety-eight collaborating experts are to be warmly congratulated on the completion of what is undoubtedly a great work and a very helpful source of reference.

Invertebrate Zoology.

Handbuch der Zoologie: eine Naturgeschichte der Stämme des Tierreiches. Gegründet von Prof. Dr. Willy Kükenthal. Herausgegeben von Dr. Thilo Krumbach. Dritter Band: *Tardigrada, Pentastomida, Myzostomida, Arthropoda: Allgemeines, Crustacea, Arachnoidea.* Dritte Lieferung. Pp. 273-384. n.p. Vierte Lieferung. Pp. 385-496. 12 gold marks. Fünfte Lieferung. Pp. 497-592. Vierter Band: *Progoneata, Chilopoda, Insecta.* Dritte Lieferung. Pp. 241-352. n.p. Vierte Lieferung. Pp. 353-448. 10 gold marks. Fünfte Lieferung. Pp. 449-576. 13 gold marks. (Berlin und Leipzig: Walter de Gruyter und Co., 1926 and 1927.)

The third part of Vol. 3 of this work opens with a short general introduction to the Crustacea, appended to which is a useful glossary of the terms employed in the description of the skeleton. A systematic account, by Prof. E. Wagler, of the Branchiopoda occupies the remainder of the part and is unfinished. A careful description is given of the external features and the internal anatomy, taking the organs system by system. Due attention is devoted to the secondary sexual characters, to the two kinds of eggs—immediate and resting—and to the development, and brief reference is made to gynandromorphs. The biology of the Branchiopoda is a very satisfactory part of the account and includes consideration of seasonal variation in size and form of the carapace, a detailed description, based on the work of Storch, of the food-filtering mechanism, pairing, and the life-cycle of monocyclic and polycyclic species.

The account of the Crustacea is continued in Part 4 of Vol. 3 of this work. Prof. G. W. Müller contributes a good description of the Ostracoda, which takes due note of internal structure as well as of external features, and deals adequately with the biology, the remarkable spermatozoa (said to be not only relatively but

also absolutely the largest known), and with the production of light. In Prof. V. Brehm's account of the Copepoda the biology and ecology are well treated, but only five lines are devoted to the life-history of Cymbasoma (Monstrilla)—a remarkable cycle which would have justified more extensive consideration. The same author has contributed a short account of the Branchiura. Prof. Hj. Broch is responsible for the adequate description of the Cirripedia, Prof. Zimmer for the general introduction to the Malacostraca (which contains a useful schematic representation of the stomach), and Prof. Thiele for the account of the Leptostraca.

The third and more than half of the fourth part of Vol. 4 are occupied by the account of the Chilopoda by Dr. Carl Graf Attems. This follows the lines of the same author's work on the Diplopoda in parts 1 and 2. Especially noteworthy are the accounts of the glands, the sense organs, the alimentary and vascular systems and the development. Some 20 pages are devoted to a consideration of the distribution of the Chilopoda, and 50 pages to the classification, in which tables are provided for the differentiation of the genera. Appended is a list of works on Chilopoda. The author is to be congratulated on his account of the Myriapoda, admirable both in text and in illustrations. The remainder of the fourth part is devoted to an unfinished general introduction to the Insecta by Dr. A. Handlirsch.

The whole of the fifth part of the fourth volume is occupied by the general introduction to the Insecta continued from the previous part, and it should be said that the author has done this difficult account with judgment and skill. He has found room to refer to some of the newer lines of work, *e.g.* to the brain and the relations of some of its principal neurones and to the symbiotic organs, and to many interesting matters in the ecology of insects, and, as we should expect from Dr. A. Handlirsch, the general account of the earlier fossil insects and the discussion of the phylogeny are of particular interest.

Plant Studies.

Manual of Cultivated Trees and Shrubs Hardy in North America: exclusive of the Subtropical and Warmer Temperate Regions. By Alfred Rehder. Pp. xxxvii + 930. (New York: The Macmillan Co., 1927.) 42*s.* net.

Mr. Alfred Rehder was custodian, under the late Prof. C. S. Sargent, of the Herbarium of the Arnold Arboretum near Boston, Mass. The Arboretum, which forms part of the botanical equipment of Harvard University, concerns itself exclusively with woody vegetation, in other words, with trees and shrubs alone. Mr. Rehder has been attached to this institution for many years, and its specialisation has enabled him to concentrate his studies on the subject of this new book. Certainly no one could be found better equipped for the work. To botanists in Britain he has long been known for his thoroughness, his conscientiousness and the care which characterises everything that comes from his pen. All these qualities are very evident in his new work.

Whilst primarily intended for botanical students of the cultivated trees and shrubs of North America, the similarity of the climate of great areas of that continent to much of ours will render the work very useful to students in Great Britain. In fact, the great majority of the species dealt with are already cultivated in English gardens, and there is no work available in the English language which deals so comprehensively with the subject in a botanical sense as this. The author commences with a synopsis of all the natural orders and families and an analytical key to the families and aberrant genera. Their sequence is according to the system adopted by Engler and Prantl in their "Natürliche Pflanzenfamilien"; it commences, therefore, with the coniferal alliance and ends with the Compositæ. As each order is dealt with in turn, a key to the genera included in it is provided and under each genus is given a key to the species. All the more important species are adequately described, so that the student is furnished with complete facilities for identifying them.

The value of such a work as this can only be genuinely estimated by continued use. It represents an enormous amount of labour, the information its nine hundred pages contain being remarkably condensed. There can be no doubt that it will for many years remain a standard work. To those in Great Britain who hold more conservative views in the matter of nomenclature than many Americans do, and look askance at the revolutionary methods of naming plants which find so much favour there, Mr. Rehder's retention of old and well-known generic names is very welcome. His adoption of the International Rules involves the use of a considerable number of specific names that are unfamiliar, but a full synonymy and a complete index always provide a guide to the species he is discussing. We have nothing but praise for this book, and feel that the more it is used the deeper will become our sense of gratitude to the author.

Handbuch der Pflanzenanatomie. Herausgegeben von Prof. K. Linsbauer. Abteilung 1, Teil 1: *Cytologie.* Band 3: *Die Farbstoffe der Pflanzen.* Von Prof. Dr. Martin Möbius. Pp. vii + 200. 14·50 gold marks. Abteilung 2, Teil 1: *Thallophyten.* Band 6: *Anatomie der Flechten.* Von Prof. Dr. Wilhelm Nienburg. Pp. iv + 137. 14 gold marks. (Berlin: Gebrüder Borntraeger, 1926–1927.)

Prof. Möbius gives a useful review of modern knowledge concerning certain aspects of plant pigmentation. While the chemical researches of Willstätter and others are mentioned, considerably more attention is given to the anatomical and cytological distribution of chlorophyll, the anthocyanins, and the many other coloured compounds found in both Cryptogams and Phanerogams. Those pigments which occur in definite chromatophores are first considered and then those of the cell-sap, of cell-membranes, of incrustations, and lastly those arising by changes of the membrane. The second

and major part of the detailed matter is conveniently classified under the headings of the various colours, green, yellow, etc. A perusal of the text, which is illustrated by 42 figures, indicates how much remains to be done on the biochemistry, cytology, physiology, and genetics of plant pigments before reasonably sure generalisations can be drawn as to their nature, origin, and functions.

Dr. Nienburg, of Kiel, has already published papers on lichens in botanical journals, and we have in the present volume a further contribution dealing with the anatomy of lichens, including some of the author's own work. The book gives a good general account of the structure of the lichen thallus and of the variations shown by the different regions of the thallus and by the fungal and algal constituents. The text is clearly written and profusely illustrated by figures, which are good, with the exception of a few which might have been omitted without detriment.

The greater part of the volume is confined to vegetative structure, and here the sections on the anatomical relation between fungus and gonidia, the range in the structure of the cortical layer, and the types of areolated thallus are especially interesting. There is also a short section describing the main types of reproductive structures.

The author has set himself a difficult task in attempting to write an account of the lichens from the purely anatomical viewpoint, and one cannot help feeling that a more general account would give greater satisfaction. Nevertheless, this volume may be commended to the student as an excellent account of the range of structure and as a good basis for further study on the group from either the structural or systematic point of view.

Everyday Physiology.

Nerves, Master-System of the Body. By Dr. David Fraser Harris. (The Modern Health Books.) Pp. 222. (London: Faber and Gwyer, Ltd., 1927.) 3*s.* 6*d.* net.

THE nervous system is, to the lay mind, the most mysterious and most difficult of understanding of all the complicated structures which make up the human body. In spite of this, or perhaps on account of it, no system is more readily blamed for vague and inexplicable symptoms, lapses of temper and lack of self-control, and failures in social or public duties. Prof. Fraser Harris, the editor of the "Modern Health Books," has produced the most important of the series. It gives the reader, in simple and compact form, a general survey of the anatomy and physiology of the nervous system and a brief explanation of the relationship between the brain and the mind and common nervous symptoms. The latter subject is a most difficult one to place clearly before an individual not scientifically trained. Modern psychology is in a very unstable condition, and it is inevitable that the explanations given by the author of this book should be in direct opposition to the views of one or more of the various schools of psychological teaching. These, however, do not concern the average person, and if the book guides its readers away from the tendency to dwell on 'nerves' as a mysterious and uncontrollable affliction, it will serve its purpose.

Readable Physiology and Hygiene: a Book for Beginners. By Dr. J. Argyll Campbell. (Bell's Natural Science Series.) Pp. xiv+229. (London: G. Bell and Sons, Ltd., 1927.) 3*s.* 6*d.*

To those of the general public who wish to know something about the working of their bodies and about the laws of healthy living, and as an introduction to physiology for the serious student, this little book may be confidently recommended. It gives in a readable form an outline of the more important facts of physiology: in addition, attention may be directed to two features which are not found in the average text-book dealing with this science. In each section those who have made outstanding contributions to that branch of the science, from the time of Hippocrates onwards, are briefly referred to: and since hygiene is part of the author's text, reference is made to certain subjects which are not ordinarily dealt with in physiological literature, such as climate, clothes, ventilation and the influence of light upon the organism. The illustrations are varied, and range from diagrams of histological subjects to photographs of famous scientific workers or explorers.

Modern Astronomy.

Astronomy: a Text Book. By Prof. J. C. Duncan. Pp. xiv+384+64 plates. (London and New York: Harper and Bros., 1927.) 12*s.* 6*d.* net.

THIS volume has at least three attributes which mark it as a very successful outcome of the author's intention to produce a book presenting a general view of the science of the stars which is suitable for the use of beginning classes in astronomy in colleges and universities: (1) the subject matter is clearly and attractively presented, due largely to (2) good type, which is varied to facilitate reference, to indicate material for first reading, and to introduce the reader to the latest results but requiring further comfirmation; (3) the text is unusually well illustrated by photographs and diagrams.

The earlier chapters are necessarily devoted to the geometry of the motions and the phenomena relating to the members of the solar system; two chapters on the optics of the telescope and on spectroscopy are here rightly introduced. Six chapters then present a succinct account of our knowledge of the stars and nebulæ. The concluding chapter outlines the theories of cosmic evolution. The chapter on nebulæ, containing a number of beautiful reproductions, deserves special mention.

The book is so well planned, that perhaps it is more difficult to pass by a few shortcomings without comment. To the reviewer it seems an omission, in a work of this scope and purpose, not to indicate more definitely the routine or special work done by the observatories of the world in collaboration with

one another or as independent units. The following examples may be given. The fundamental work of the transit instrument and meridian circle receives insufficient attention; no short descriptions are given of a modern astronomical clock, a chronograph, or the impersonal wire micrometer. No mention, even, is made of the largest piece of international co-operative work ever undertaken in astronomy—the Astrographic Chart and Catalogue—or of the past and projected Eros campaigns for the measurement of the sun's distance. The trigonometric determination of stellar parallax by photographic methods (a great task on which several observatories are engaged) is dismissed in a few lines. The various methods now available to astronomers for measuring stellar distances might have been conveniently summarised, instead of leaving the reader to connect them up for himself from three or four separate passages. The same remark applies to the various methods of determining the solar parallax. But the concluding thought is that the student is indeed fortunate who has prescribed for his study Prof. Duncan's book with its wealth of illustrations and explanatory diagrams. In Great Britain, where astronomy is not taught in the colleges and universities to the same extent as it is in America, this book can be warmly recommended to those who wish to have an authoritative, comprehensive, and up-to-date outline of modern astronomy.

Atomic Theory and Radiation.

Problems of Modern Physics: a Course of Lectures delivered in the California Institute of Technology. By Prof. H. A. Lorentz. Edited by Prof. H. Bateman. Pp. vi+312. (Boston, Chicago, New York and London: Ginn and Co., 1927.) 16*s.* 6*d.* net.

THE course of lectures from which this book arises was delivered early in 1922 and bears the subtitle, "Light and Matter, with some Considerations of Relativity." It is necessary to bear this in mind or the reader of this book may be somewhat disappointed. The main title and the date of publication might lead him to expect rather different and more modern subject matter. Let the reader then abandon all thought of finding here any discussion of the recent advances of the quantum theory. Let him turn to the book for an illuminating exposition of classical radiation theory, with applications to a series of interesting problems such as dispersion, scattering, and the apparent boundary of the sun, the interaction of light with matter, moving and at rest, the detailed implications of the special theory of relativity, the extension to the general theory of relativity, and occasional applications to the classical quantum theory and the possible nature of light quanta. He will be amply rewarded. The exposition is of course masterly. The book may be regarded either as a supplement to the author's work, "The Theory of Electrons," or as an introduction to a study of modern problems of theoretical physics through a detailed study of classical radiation theory. From either aspect it should prove most valuable, and form part of the course of reading of every serious student.

R. H. FOWLER.

Atomic Theory: an Elementary Exposition. By Prof. Arthur Haas. Translated by Dr. T. Verschoyle. Pp. xiv+222. (London: Constable and Co., Ltd., 1927.) 10*s.* 6*d.* net.

THE most valuable features of this book are the chapters on the hydrogen atom and on the general theory of spectra, which together form rather more than half the text. The material here is well selected and logically arranged, and, it need scarcely be added, both accurate and up-to-date. Students wishing for an elementary account of this new and important branch of physics could scarcely do better than consult these two chapters. The remainder of the book, dealing with the elementary theory of quanta, Röntgen rays, and the theory of the elements, is somewhat too condensed even for an elementary treatise, and would bear expansion.

Text-Books and Treatises on Chemistry.

Second Year College Chemistry. By Prof. W. H. Chapin. Second edition, revised. Second impression, with additional Problems and Exercises. Pp. xiii+366. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1926.) 15*s.* net.

PROF. CHAPIN'S book has a somewhat misleading title for English readers. It really consists of an introduction to physical chemistry and covers the ground extremely well. It is in no way superficial, and yet the mathematical side has been restricted to the barest minimum. The book can therefore be read with profit by students who have not yet begun the calculus. The subjects are dealt with in a commendably modern way, yet the outlook is conservative and the book is suited to the needs of English students. Some of the chapters are admirably concise yet full of interesting information; as an example, that on colloids may be mentioned. There are exercises at the ends of the chapters and a set of miscellaneous problems at the end of the book. A few carefully chosen references to literature are given. The book is very well printed and the text well arranged. The price is reasonable.

Elementary Practical Chemistry: for Students preparing for the School Certificate and Matriculation Examinations. By E. J. Holmyard. (Bell's Natural Science Series.) Pp. xvi+117. (London: G. Bell and Sons, Ltd., 1927.) 2*s.*

MR. HOLMYARD'S book provides an excellent course of work in schools up to school certificate or matriculation standard. The methods of preparation and properties of the common gases, the recognition of gases, simple exercises in volumetric analysis, and the study of several common elements and their compounds are included. Full directions for fitting up apparatus and performing experiments are given, and any particular difficulties are dealt with. The poisonous properties of carbon

monoxide might have been emphasised on p. 42, and in Experiment 49 on p. 64 the copper carbonate used would probably have the composition $CuCO_3$, $Cu(OH)_2$ rather than $CuCO_3$, as stated. The book is just large and detailed enough for its purpose, is written in a clear and interesting style, and can be recommended.

Equilibria in Saturated Salt Solutions: a Summary of the Results of the Study of the Heterogeneous Equilibria which exist in Aqueous Solutions of Electrolytes. By Prof. W. C. Blasdale. (American Chemical Society Monograph Series.) Pp. 197. (New York: The Chemical Catalog Co., Inc., 1927.) 4.50 dollars.

PROF. BLASDALE'S book is a phase rule study of the conditions of equilibrium in saturated aqueous solutions of neutral salts, including, however, one chapter in which acid and basic salts are considered. The restriction of the scope of the book to aqueous electrolytes is a clear benefit, since the number of examples available is already sufficiently large, if not indeed excessive, and any attempt to include other systems would have made it necessary to write a different and probably a much larger book. Starting, therefore, with a chapter on water, the author goes on to consider the properties of saturated aqueous solutions of a single salt which forms one or more hydrates, and then passes to systems of greater and greater complexity, until in the final chapter a climax is reached in the consideration of six-component systems derived from water and salts which yield six different ions, the principal example cited being the calcium-containing minerals of the Stassfurt salt deposits.

In certain places the author makes a half-hearted attempt to discuss the structure of salt-hydrates in the light of modern theories of valency; but since the phase rule has the great merit of being independent of all theories of valency, these paragraphs add but little to the value of the narrative. The subject is, however, treated in a simple and logical manner, the printing and paper and general 'get up' of the volume (which includes 78 excellent diagrams) are attractive, and the book can be heartily commended to the general reader, and even more emphatically to those directly interested in industrial problems in which the crystallisation of aqueous salt solutions plays an important part.

T. M. L.

Trattato di chimica generale ed applicata all' industria. Per Prof. Dott. Ettore Molinari. Vol. 2: *Chimica organica.* Parte prima. Quarta edizione riveduta ed ampliata con la collaborazione del Prof. G. Bargellini. Pp. xxiii + 660. (Milano: Ulrico Hoepli, 1927.) 45 lire.

THIS volume, published a few months after the death of the author, has been prepared with the help of Prof. Bargellini, who has revised the sections dealing with the theory of the aliphatic compounds.

The general scheme of the earlier editions has been retained, a few alterations only being made in the arrangement of the subject matter. The tables of statistical data, which form a characteristic feature of the work, are, in many cases, extended to include those for the year 1925. Ample reference is made to such recent developments as the manufacture of methanol from carbon monoxide and hydrogen, but in certain cases, for example, the preparation of absolute ethyl alcohol by the benzene process, more detailed description seems desirable.

In general the proofs have been carefully read, but obvious slips, all of which appeared in the preceding edition, occur in the table on p. 262 and on pp. 16, 79, 89, 585, and 595. No index is provided, but a complete index to the volume on organic chemistry is to be supplied with Part 2, which is already in the hands of the printer.

The steady demand for new editions is evidence of the welcome reception accorded to the book, and the price is commendably low. T. H. P.

Photographic Technique.

La Technique photographique. Par L.-P. Clerc. Tome second. Pp. xxi-xxxvi + 461-850. (Paris: Paul Montel, 1927.) 2 vols., 90 francs.

THE first volume of this work was noticed a short time ago (NATURE, Aug. 20, p. 256), and this second is in every sense a continuation and completion of it. The pages in the two volumes are numbered consecutively throughout and at the end is an index to the whole. The subjects included in this second volume are the various printing methods, classified according to whether the sensitive compound is a salt of silver, a salt of iron, or a chromate; these are treated of in considerable detail. The last section includes methods of reproduction, enlarging, projecting images (lantern slides), stereoscopic work, and photography in colours. Then follow shorter chapters on kinematography, photo-mechanical processes, and radiography. The first appendix is a chronology of processes and their applications, and the second appendix is a bibliography classified according to subjects. Thus the two volumes form a complete treatise on technical photography from the general point of view, and the large experience that M. Clerc has had, and his painstaking study of the subject, are a sufficient guarantee of trustworthiness and wise selection. As we remarked with regard to the first volume, the figures are all illustrative and nearly all seem to be original, but we think that the number in the second volume might have been somewhat increased with advantage. Taking the work as a whole, it is much to be commended as a rather large general manual of the subject. C. J.

Photographic Facts and Formulas. By E. J. Wall. Pp. viii + 386. (London: Chapman and Hall, Ltd., 1927.) 16*s.* net.

PROBABLY every earnest student has a method of making extracts and cuttings relative to the subject that he studies, and of classifying them for ready reference. This volume is a reprint of such a collection put into a convenient form to meet the needs of the average photographer. It goes rather

beyond this, indeed, including such formulæ as those for silvering glass and blackening wood and various metals. The items are classified into the various processes and methods, and it would be difficult to find any subject not included if we except purely manufacturing operations such as emulsion making and plate making. The references to the original publications are not given, but this will not be much of a disadvantage to the majority, as Mr. Wall is a careful editor and has had a large experience. We notice, however, that it is stated that the Paris Congress adopted *f*/10 as the unit of lens aperture. This is true, but some twenty years ago or more, the Congress withdrew that, and at the suggestion of the Royal Photographic Society of Great Britain, adopted instead the natural unit of *f*/1. This is now the official unit and the official method of its expression in Great Britain and on the Continent, and the series is obtained as usual by halving the area of the aperture at each step.

School Mathematics.

(1) *Mathematics for Students of Technology.* By L. B. Benny. Senior Course. Pp. viii + 451 + xxvii + vii. (London: Oxford University Press, 1927.) 10*s.* 6*d.* net.

(2) *Elementary Trigonometry.* By C. V. Durell and R. M. Wright. (Cambridge Mathematical Series.) Pp. xviii + 288 + 31 + xxiv. (London: G. Bell and Sons, Ltd., 1927.) 5*s.*

(3) *A Concise Geometrical Conics.* By Clement V. Durell. Pp. xvi + 99. (London: Macmillan and Co., Ltd., 1927.) 4*s.*

(1) In recent years, largely owing to the influence of the late Prof. Perry, the teaching of mathematics, especially to technical students, has become refreshingly practical. But it has often been found that students brought up under the new system, who were supposed to possess a 'working knowledge' of elementary mathematics, were not in fact able to apply this knowledge with any success. This has sometimes been due to a lack of appreciation of fundamental principles, but sometimes also merely for lack of practice at elementary processes of manipulation. The necessity for drill in the mechanical work of elementary mathematics is therefore becoming more recognised. The question has lately been considered and reported upon, from one point of view, by a committee of the Mathematical Association.

Mr. Benny shows a just appreciation of these points, and his book should be very useful to the students for whom it is intended. It forms a senior course and includes differentiation and integration even of the exponential and logarithmic functions. The algebra and trigonometry include revision of quite elementary work. There are also useful chapters on vectors and solid geometry.

(2) No teacher responsible for the selection of a text-book for school use should neglect to examine this volume. The modern tendency is to introduce trigonometry as early as possible in the mathematics course. Part I. of the present volume can be taken very early; it deals with the right-angled triangle, and the numerical work is not so heavy as to obscure the principles. Part II. deals with the general triangle and mensuration; this last subject is treated fairly completely and will naturally be taken in conjunction with mensuration in arithmetic and areas in geometry.

In Part III. the general angle is introduced on the basis of co-ordinates, which will be familiar from graphical work.

Another modern principle with which the book accords is the inter-penetration of mathematical subjects. Treatment of different subjects in water-tight compartments is now obsolete.

Formulæ dealing with compound angles $(A \pm B)$ are included in Part III., so that the volume covers the ground up to matriculation and first school certificate examinations, including the subject usually known as 'Additional Mathematics.'

(3) This volume is intended for those whose main study of the conic is on other lines. Teachers are aware that mathematical students do not readily acquire from courses of projective and analytical geometry that familiarity with the conic which was derived from the old-fashioned course of geometrical conics. On the other hand, they realise that geometrical conics is a subject barren of new ideas. In this short volume Mr. Durell has collected just what is needed of the subject, and has avoided the overloading of the book with matter which is best dealt with by other methods. A. R.

Contributions to Mathematics.

Integral Bases. By Prof. W. E. H. Berwick. (Cambridge Tracts in Mathematics and Mathematical Physics, No. 22.) Pp. vi + 95. (Cambridge: At the University Press, 1927.) 6*s.* 6*d.* net.

This latest addition to the well-known series of Cambridge mathematical 'tracts' gives an exposition of the author's own researches in the subject and contains, first of all, an account of a number of new methods for determining the modulus of complex integers in the field of algebraic numbers defined by an arbitrary irreducible equation

$$\theta^n + a_1\theta^{n-1} + \ldots + a_n = 0,$$

and then the application of these methods to the particular field defined by

$$\theta^n - a = 0.$$

This application is developed in detail.

It is a little larger than the average Cambridge 'tract' and is very closely packed. The author writes in a competent way and does not waste any words, so that a research student is likely to find here all the material he requires. The value of the work is probably increased by the fact that the general problem first considered is not solved completely in all its details. It leads to a process of approximation of which four stages have been worked by the author, three of them being given in the 'tract.' The fourth stage is not final, so that the domain opened up by the author's researches is not yet exhausted.

The two chapters devoted to numerical illustrations form a pleasing feature which will appeal to the reader who finds abstract discussions rather difficult. S. Pollard.

Scientific Papers. By the late Prof. Shizuwo Sano. Pp. xiii + 340. (Tôkyô: Iwanami Shoten, Kanda, 1926.) 5 yen.

THIS handsome memorial volume to the late Prof. Sano contains a short but satisfying account of the author's life, together with a reprint of his contributions to mathematical physics. Of Sano's earlier papers the most important is one (1906) on the equilibrium of fluids in an electromagnetic field. Sano had a remarkable aptitude for mathematical analysis involving harmonic functions, and much of his leisure was devoted to research on this branch of the subject. As he was chiefly occupied with thermodynamics, he published only two papers in the field of applied mathematics, one on wave-propagation in the air, and the other on an application of Fredholm's theorem to waves produced on the surface of an elastic solid. Indeed his chief contributions were in thermodynamical investigations concerning electricity and magnetism, and on the equilibrium between different phases of a substance. The present volume contains English translations of three papers originally printed in German. It makes a very worthy memorial to the brief life of one of the abler exponents of recent theoretical physics in Japan.

Technical Electricity.

Electric Switch and Controlling Gear: a Handbook on the Design, Manufacture, and Use of Switchgear and Switchboards in Central Stations, Factories, and Mines. By Dr. C. C. Garrard. Third edition, revised and enlarged. Pp. xiv + 783. (London: Ernest Benn, Ltd., 1927.) 63*s*. net.

IT is now generally recognised by the administrative department of an engineering works that the purchase and manufacture of raw materials demand the application of the same scientific methods that are employed in the designing office. The success or failure of a factory depends mainly on the spirit animating the organisation, but scientific specifications are a necessity. The leaders of industry recognise the value of research and experiment, and this augurs well for the future.

To cheapen manufacture, however, standardisation is necessary. In the manufacture of switch and controlling gear, very little advance has been made in this direction. In the manufacture even of such everyday apparatus as high-tension switchboards, the designs of different manufacturers are widely different. Volumes like the present, which help to crystallise design, are therefore of great practical value. The descriptions given of the various types of lightning arrester are very instructive. It is pointed out that electrolytic cells are more expensive than other arresters to maintain in good working order owing to the growth of fungi. Some engineers also condemn them on the ground that they cause travelling waves. As a result of researches, the lead oxide film lightning arrester has been developed. The principle of its action is that lead peroxide, which is an electric conductor, on heating is changed into litharge, which is practically an insulator.

Electrical Condensers: their Construction, Design, and Industrial Uses. By P. R. Coursey. Pp. xxiv + 637. (London: Sir Isaac Pitman and Sons, Ltd., 1927.) 37*s*. 6*d*. net.

IT is now nearly 200 years since the discovery of the electrical condenser. It was first regarded as a scientific toy and next as a piece of laboratory apparatus with a somewhat limited application in connexion with telegraphy. Finally, many important industrial uses have been found for condensers in electric lighting and more recently in radio broadcasting. In most cases the value of their capacities can be computed with high accuracy and in all cases it can be easily measured.

This book will prove of use to engineers and scientific men. After an interesting historical introduction the properties of dielectrics are discussed at length. Formulæ are next given for calculating the capacity of condensers and for computing approximately the capacity of overhead wires, the capacity between wires and the capacity between a wire and earth being considered separately. The use of condensers for radio purposes is explained and several types of variable condensers with appropriate formulæ are described. The relative advantages of air, glass, paper, mica, and other insulators as dielectrics are carefully described. Finally, the applications of condensers in improving the power factor in alternating current systems, in protecting power distribution circuits from surges, in electric furnaces and in making condenser telephones and microphones are explained. A very full bibliography of the subject is given. The diagrams are clear and the photographs are more interesting and instructive than is usually the case in technical books.

Practical Radio Construction and Repairing. By J. A. Moyer and J. F. Wostrel. Pp. vii + 319. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1927.) 10*s*. net.

THE title of this book is well chosen. The book will be of use not only to the amateur constructor and repairer, but also to the radio dealer who has to test and repair radio sets. The ordinary reader will get a good introduction to modern radio nomenclature. He will learn all about 'trouble shooting' and the 'troubleman,' battery eliminators, trickle chargers, and the squealing of amplifiers. A list of questions is given which, if answered by the consumer, will probably greatly accelerate the time taken for repair. A list of fifty-three possible sources of trouble is given. Fourteen of these are due to the faulty electric equipment of the house or of a neighbour's house, and twenty-nine are outside the house, nine of which being due to the power companies' mains. The branches of trees blown by the wind sometimes touch power transmission lines, producing sparks and hence radio waves. At one place in America an intermittent arcing circuit caused in this way produced serious interference to all radio sets in the neighbourhood of the power transmission line.

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Mammoths and Man in the Transvaal.

By Prof. RAYMOND A. DART, University of the Witwatersrand, Johannesburg, South Africa.

RECENTLY there were brought to me by Mr. Arthur Sheppard, of Westminster Buildings, Johannesburg, two mammoth teeth, accompanying stone implements of the older palæolithic type, retrieved by his brother Henry Sheppard, during the excavation of a dried portion of the Vaal River bed, near Bloemhof, in the south-western Transvaal.

THE VAAL GRAVEL TERRACES.

Before describing the morphological features of the teeth and the implements, the peculiar interest of the discovery will be enhanced by a general statement of our present knowledge of the Vaal River gravels in general. There can be little question that the determination of the precise geology of these gravels is fundamental to the future of anthropological investigation in this country, and it is deplorable that so little accurate information is available concerning the history of this great watershed, which has already yielded the bones of *Australopithecus africanus* and Boskop man, and is loaded from end to end with stone implements, rock engravings, and other evidences of primitive man's handicraft. There are at least three gravel deposits, each of different geological age, in the watershed. Du Toit (*Ann. Rep. Geol. Comm.*, **11**; 1906) has written as follows:

"The gravels are situated at various levels as well as at varying distances from the river, and though they form a number of terraces, it is not easy to determine their relative age. On the west of the Vaal the terrace is finely developed at Klipdam, where it has an altitude of 200 feet above the river, and a distance from it of 3½ to 6 miles."

It appears that this highest and presumably oldest terrace of the Vaal valley recurs at approximately the same height above the river at Barkly West, 1½ miles north-west and also north-east of the town, and also at Droogeveldt, where it is 300 feet or more above the river and 4 or 5 miles from it. Hitherto no fossils have been described from this most ancient of the terraces.

At Waldeck's Plant, Delpoort's Hope, Niekerk's Rush, and other places west of Barkly West, this very old terrace is not present, but there is a second gravel terrace on a lower level from which stone implements of the old palæolithic type are recovered in great numbers. A group of these secured from diamondiferous gravels at a depth of 18 to 30 feet in the terrace in the Niekerk's Rush area, were described by one of my students some time ago (E. T. Hodkinson, *S.A. Journal of Science*, vol. 23; 1926). From what is presumably the same terrace, Richard Beck (*Geol. Mag.*, p. 49; 1906), during the last visit of the British Association for the Advancement of Science to South Africa, secured a fragmentary tooth, determined by Johannes Felix as *Mastodon* (*Bunolophodon*) *sp.*, at Waldeck's Plant. The height of this more recent gravel terrace at Waldeck's Plant is 60 to 80 feet above the river bed.

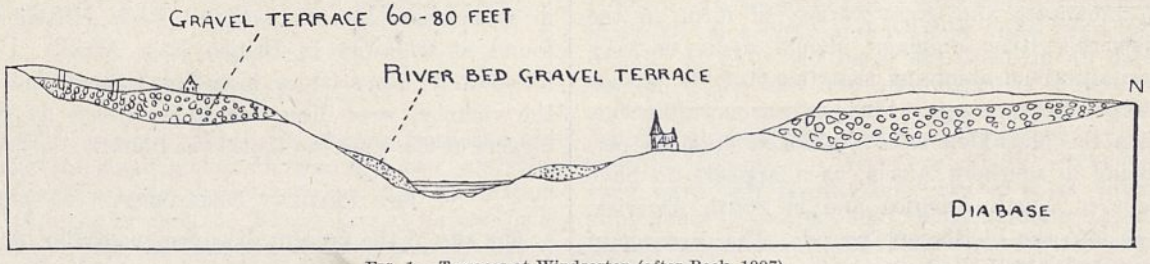

FIG. 1.—Terraces at Windsorton (after Beck, 1907).

Dr. S. Haughton (*Trans. and Proc. Geol. Soc. of S.A.*, vol. 24, 1922) described a new species of elephant (*Loxodonta griqua* Haughton) possibly ancestral to the modern African elephant, and a new genus and species of giraffe (*Griquatherium cingulatum* Haughton), as coming from the same 60-80 ft. terrace.

In commenting on these fossils, Haughton referred to the importance attaching to them, seeing that while none of them came from the highest and oldest of the terraces—all of them probably coming from the 60 ft. terrace—they were all three Mastodon, Loxodonta, and Griquatherium—sufficiently removed from the existing fauna and close enough to known more northern forms to be classed as Pleistocene. He prognosticated also that "it should be possible in course of time to institute a palæontological time scale for the various terraces, and to attempt to correlate them with the well-defined but little-known high-level gravels and terraces of the belts nearer the coast, or even to find some association between them and the Tertiary incursions of the sea, such as took place in Miocene and Mio-Pliocene times."

According to von Zittel ("Handbuch der Paläontologie," vol. 4, p. 473, 1893) the Mastodon is not characteristic of the palæontological fauna of Africa, Europe, and Asia in geological times later than the Pliocene. The discovery of numerous human implements of the older palæolithic period type, but of very advanced workmanship and great variety of form, in the Niekerk's Rush diggings, should make us very hesitant about assuming that this 60-80 ft. terrace was of Pliocene age. Since it was not Pliocene, then the Mastodon is to be looked upon as persisting in southern Africa, as it appears to have done in North America and in South America, well into the Pleistocene period. The presence of an advanced Loxodont elephant and of human implements as above stated in the same stratum, is further evidence that a persistence of the mastodon into the Pleistocene period is the proper interpretation, and if so, then von Zittel's table needs revision in this respect for southern Africa at least.

In the year following Beck's discovery, 1907, E. Fraas (*Zeitschr. Deutsch. Geol. Gesellsch.*, Bd. 59, Heft 2, p. 232) described the fragment of mastodon tooth further, but owing to its incompleteness was unable to decide its zoological position in any greater detail; but as Fraas has pointed out, we can certainly assume a very remote age for this Pleistocene deposit on account of the presence of the mastodon, "since it is not likely that these relict forms from the Tertiary epoch persisted long in proximity to true elephants."

In the same paper Fraas gave from the description and drawing supplied by Beck an excellent account of the geological conditions obtaining in the region near Barkly West. He pointed out that there existed below the 60-80 ft. terrace a still lower deposit through which the present river was at present cutting its channel. From these river bed gravels he described the teeth of a horse, a new variety of hippopotamus (*H. amphibus*, var. *robustus*). It would therefore appear that there are at least three gravel deposits at different levels in the valley.

Beyond the teeth described by Fraas, I knew of no animal remains secured from the river bed gravels before these mammoth teeth were brought to me. On a recent visit to Cape Town, however, I learned from Dr. S. H. Haughton that he had been asked to identify a portion of a tooth which had been presented to the MacGregor Memorial Museum, Kimberley, by Mr. H. Else.

This tooth had been recovered at a depth of 5 feet in the river bed gravel, 1½ miles below The Bend on the Vaal River, and was determined by Dr. Haughton some years ago as *Elephas* (cf. *antiquus*). From the photographs which I saw of this tooth, it appears to represent an elephant entirely different from any of the living or known fossil forms from southern Africa. It resembles in some characters *E. antiquus Recki* (Dietrich), found at Oldaway in British East Africa. Unfortunately, other bones, including tusks found in the vicinity, were discarded as worthless by the diggers at the time the tooth was found.

The Present Discovery.

The site of the present discovery near Bloemhof is shown in the accompanying photograph (Fig. 4) and diagrammatically in the accompanying diagram (Fig. 2) prepared for me by Prof. Paul Kovaloff, consulting mineralogist, Westminster Buildings, Johannesburg, and previously assistant professor of mineralogy and crystallography in the Petrograd Mining Institute (High School of Mines), who visited the spot, and redrawn by Mr. E. A. Thomas. It will be seen that the discoveries were made on the site of the diamond diggings (stippled), in the older and straighter river bed at a depth of less than 4 to 5 feet in the gravel. The depth of water in the new bed of the river is usually 4 feet below the level of the old bed. The depth of the new bed is consequently 7 to 10 feet below that of the old bed, which latter, however, becomes entirely flooded even to the top of the banks and the rim of the island in the rainy season.

The banks of the river and the island itself are composed of sandy soil, presumably river-borne. This sandy soil layer has been discovered by sinking a well on the island to have reached a depth of

37 feet before the river gravel bed was struck. It is not clear whether this island is the relic of the valley through which the river has cut its channel, or whether it has been formed by the banking up of the debris behind some massive obstruction in

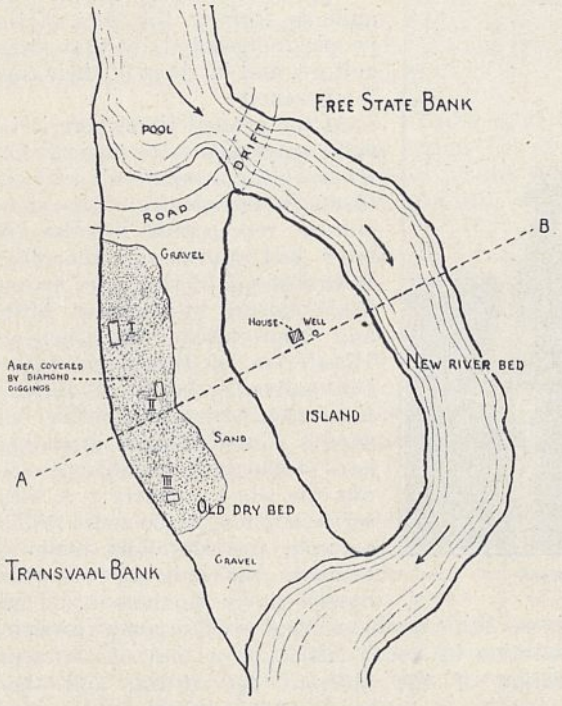

FIG. 2.—Plan of Bloemhof site.

the old channel. The wide detour from the old relatively straight bed to the new bed, and the comparison to be drawn between the constitution of the banks and the island, would *prima facie* indicate that the island is a relic of the old valley. In any case, the depth of the sandy banks and of the sandy stratum of the island bespeak a considerable age for the underlying gravel stratum, whatever the method of formation.

No data are available as to whether the old river bed gravel at Bloemhof is of the same age as the third and youngest terrace (or river bed gravel) in the Barkly West region near Waldeck's Plant. It may represent a fourth and more recent deposit, but meantime it may be presumed that they are of the same age, and that the gravel from which the present teeth are recovered is comparable with that from which the horse, rhinoceros, and buck teeth were retrieved by Beck, and described by Fraas.

The accompanying photograph (Fig. 4) shows, reading from left to right, Prof. Kovaloff, Mrs. H. Sheppard, Mr. H. Sheppard, and Mr. Ernest Sheppard, alongside their mining outfit in the dry river bed near site No. 2, where the second discovery of a tooth (the larger one) was made. The native is seen on the right looking into the pit from which the larger tooth was recovered. In the background of the picture the tree-covered island is seen shelving down to the gravel bed. In the distance and to the left the right bank of the Vaal is clearly apparent.

In the diagram (Fig. 2) the sites of the three different discoveries of separate mammoth teeth are marked. They were each in separate pits and the discoveries were made at intervals of days or weeks from one another. There is little likelihood that any one of them belonged to one and the same animal as any one of the others.

The animal remains forwarded from Bloemhof consisted of two right upper molars. The first tooth of the same character found on the first occasion was thrown away into an old pit as of no interest. Indeed, these teeth also would have been discarded if it had not been for the interest of Mr. David Draper, honorary curator of the Johannesburg Geological Museum, who, when he heard that such objects were being recovered, insisted on their being brought to Johannesburg for examination.

There can be no question that the teeth belong in age to the geological deposit in which they were found. If they had been laid down in an older deposit which had been disintegrated afterwards and re-formed in this gravel, these teeth certainly could not have been discovered in their present unworn condition. When originally excavated they were very fragile, and both of them during subsequent handling split longitudinally in the plane of the enamel plates into numerous fragments; nor was the general condition of the teeth improved by the crude efforts made to keep the plates together by driving an iron nail through one of the teeth, although this measure served to keep the one tooth complete, at least so far as its total length is concerned. Both of the teeth are highly mineralised, and sand and small pebbles of the diamondiferous gravel were firmly adherent, forming an incrustation to the sides of the teeth, more especially to the smaller of the two. The rounded worn nature of the hard gravel pebbles, as Prof. Kovaloff pointed out to me, is in strong contrast with the unworn nature of the teeth, which show little trace of water attrition, and consequently could not have suffered much from water transport. There is every reason to believe that the animals

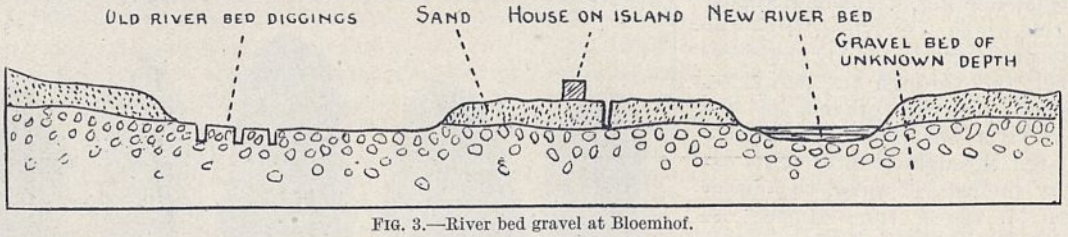

FIG. 3.—River bed gravel at Bloemhof.

to which they belonged lived during the period when this gravel deposit was originally laid down, and that they inhabited the same or a not very distant region of this watershed.

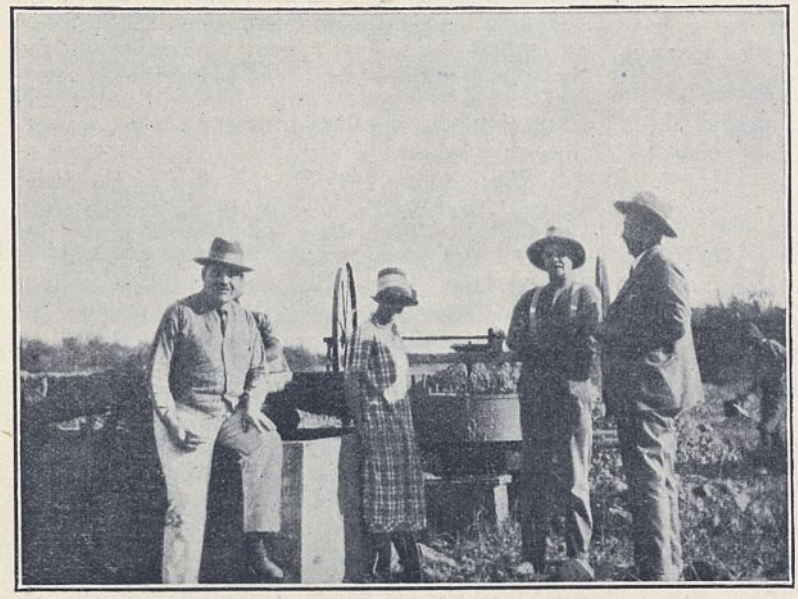

FIG. 4.—Party with mining outfit in the dry river bed at Bloemhof.

THE IMPLEMENTS.

Throughout the whole of the area of the old river bed where the workings are (indicated in Fig. 2), implements of human manufacture occur in the same excess as, or an even more extensive prodigality than, characterises their occurrence elsewhere along the Vaal watershed. They occur literally in thousands, and represent every grade of wear, from implements so waterworn as to be just recognisable in their general shape and outline, to implements with cleanly fragmented, non-patinated surfaces and edges which appear as if they had left the workman's hands only yesterday. Some of these are depicted in Fig. 5. It would appear that the whole watershed, from the remote period indicated by the 60-80 ft. level, and through the period represented by the gravels of the present river bed, has been densely populated throughout most of its extent by prehistoric races, the major portion of whose time appears to have been utilised in fabricating stone implements. The collective industry of this workmanship, even in one such site as this at Bloemhof, is really prodigious. That such industry was characteristic of the people higher up in the old watershed and perhaps more remote in time, is abundantly attested by the implements bearing marks of water attrition; but that the industry was characteristic of the Bloemhof area itself is equally evident from the freshly made and unworn implements found on the spot. The simultaneous presence of relatively unworn elephant-teeth and unworn implements is also presumptive evidence that these animals formed the diet of the people represented by that stone culture, and in short of their contemporaneity.

At the present time there is insufficient evidence to separate the stone cultures represented by the 60-80 ft. terrace from the stone culture represented by the old river bed gravels at Bloemhof. Both belong to the older palæolithic culture of southern Africa and approximate the Chelles—Mousterian of Europe in facies. Both appear to be equally distinct from the newer palæolithic culture or flake industries characteristic of the surface finds throughout the whole country. A large series of these implements will be secured, and an effort made to compare the industry with that described by Hodkinson. There is no lithic problem of greater urgency awaiting solution in South Africa than that of the separation of the different age strata, and there is every likelihood that the analysis of the Vaal valley in this respect will be of premier value.

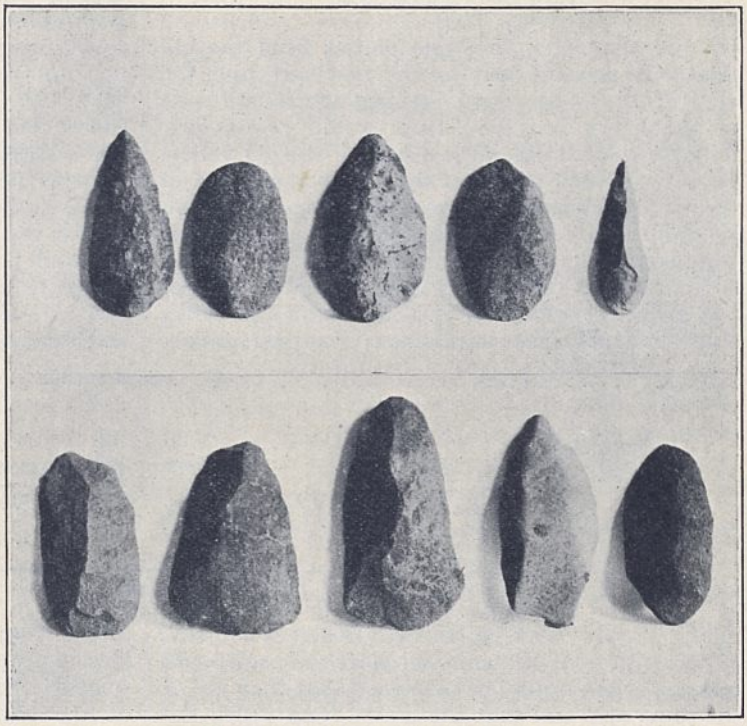

FIG. 5.—Implements of Lower Palæolithic type from river bed gravel at Bloemhof.

Comparison with other Teeth.

In assessing the value of such a new discovery it is necessary that previous discoveries of similar or related forms, and especially the local fauna, be compared with the specimens. Pohlig (according to W. B. Scott, Third and Final Rep. of Geol. Survey of Natal and Zululand, 1907) has classified the elephants subgenerically as follows :

"1. Archidiscodonta. Type *E. meridionalis*.—Transition to the following group formed by *E. planifrons*. Tapinodiscal, laticoronate, short and pachyganal molars. Parsilamellate (mostly only 15 lamellæ in M. 3).

II*a*. Loxo-(disco)-donta. Type *E. africanus* (and *E. priscus*).—Transition to the following group formed by *E. antiquus*. Hypselodiscal, angusticoronate molars.

II*b*. Polydiscodonta. Type *E. primigenius*.—Transitions to the preceding group in *E. indicus* and *E. namadicus*. Hypselodiscal, laticoronate, long, endioganal molars. Densilamellate (mostly more than 20 lamellæ in M. 3)."

The Vaal valley elephant tooth secured by Haughton falls definitely into the Loxodonta group II*a*, to which the modern African elephant belongs. The only other elephant remains south of the Zambezi that have been described are the two lower molars discovered by Mr. Anderson on the coast of Zululand "scattered over a large flat outcrop of shales which occurs below the level of ordinary low-water mark, and is only exposed under the exceptional circumstances of a strong south-easterly gale, and a neap tide, when the large covering of sand is removed." These teeth were referred to a new and extinct species, *Elephas* (*Loxodon*) *Zulu* by Scott, and they were associated with new and extinct species of the hippopotamus, buffalo, and rhinoceros.

According to Scott, *E. Zulu* "might almost be described as intermediate between the Archidiscodonta and the Loxodonta." Its "third lower molar is very large, almost equalling in size that of the most gigantic modern African elephants and in shape is elongate and rather narrow, though broader relatively than *E. africanus*, so much so as to verge on the laticoronate type . . . the degree of abrasion is such that the height was less than in *E. africanus*, though probably not sufficiently [low] to deserve the name Tapinodiscal . . . the number of ridges cannot have been less than 12, and may have been 13 . . . the pattern is decidedly less loxodont than in the recent African species. The enamel is very thick (pachyganal) and very strongly crimped. The lateral terminations of the laminæ are either rounded or trifoliate, and each ridge has a feebly curved or crescentic shape, with the horns directed forward. The three posterior ridges have only the points of the digitations exposed, and of these there are four to each ridge, and those of successive rows are arranged in longitudinal rows in a manner suggestive of *E. meridionalis*. In several respects these teeth of *E. Zulu* resemble the curious molars of *E. antiquus*.

"*Measurements.*

Third lower molar	length . . .	·265
,, ,,	width	·085
,, ,,	height of posterior portion	·081."

The present teeth have nothing in common with either *Loxodont griqua* Haughton or with *Elephas* (*Loxodonta*) *Zulu* Scott. They represent an entirely different category altogether. They are respectively right and left upper molars, and both are presumably third molars. Their measurements are as follows :

	Right.	*Left.*
Third upper molar length .	246 mm.	246 mm.
,, ,, breadth .	110 ,,	100 ,,
,, ,, height of posterior portion	247 ,,	202 ,,

The enormous depth of the teeth, and consequently of the enamel plate, places both teeth, despite their abrasion, and despite the fact that they are upper molars, in the hypselodiscal class, while their great width, ¼ to ⅓ wider than even the relatively broad teeth of *E. Zulu*, transfers them also definitely to the laticoronate category. They, therefore, cannot belong to the Loxo-(disco)-donta group of Pohlig. The number of lamellæ in the teeth is 13 in the left molar and at least 16 (and probably 18) in the right molar, which is unfortunately incomplete anteriorly. The lamellæ are not compressed but are *broad* (17-19 mm. in the central portions, 13-15 mm. near the margin, and 15-17 mm. at the medial margin in the larger tooth, *i.e.* right molar ; 12-14 mm. in the central portion and 10-11 mm. near the inner and the outer margins of the smaller tooth, *i.e.* left molar). The lamellæ are considerably broader than the interlamellar discs of cementum ; the cementum is nevertheless abundant in quantity —although not so abundant relatively as in *E. planifrons* and *E. meridionalis* types. The two enamel walls of each lamella are virtually parallel with one another, the enamel is very thick (pachyganal), especially in the larger tooth, and indefinitely crimped, though not so markedly as in *E. Zulu*. The lateral terminations of the laminæ are rounded both medially and laterally in the smaller tooth ; they are rounded at the lateral margin, but possess squarish outlines at the medial margin in the larger tooth. In both teeth the ridges have a feebly curved or crescentic shape, as in *E. Zulu*, but whereas in that form, and also in *E. meridionalis* and *E. antiquus*, the lateral horns of the crescent are directed forwards, in both of these teeth they are directed backwards, as appears also to be the case from illustrations in *E. primigenius*. The shortness of the teeth, the relatively small number of lamellæ (appreciably less than 20), and their pachyganal nature are all characters which equally definitely remove the possessors of both teeth from the Polydiskodonta group of Pohlig, and relate them to the Archidiskodonta.

These teeth are equally to be differentiated from *Elephas* (*Loxodonta*) *antiquus Recki* Dietrich, secured from British East Africa, in which the length attained as much as 330 mm., the maximum breadth was 9·2 mm., and the greatest height was 165 mm., and in which the enamel pattern was also different.

The enamel is definitely crimped in both of these teeth, the crimping having a coarser appearance in the larger tooth, similar to that of *E. meridionalis*, while in the smaller tooth it was finer, like the pattern presented by *E. namadicus*, probably as a result of the presence of a thinner enamel in the smaller tooth than in the larger one. In neither tooth is the crimping quite so coarse as in *E. Zulu*, *E. antiquus*, or *E. meridionalis*; but rather of a finer type, comparable with that present in illustrations of *E. primigenius*.

There is no tendency, as occurs in *E. Zulu*, and to a more marked extent in *Loxodonta griqua*, to the throwing out of a median posterior buttress or column of enamel on the posterior lamina of each plate to give the appearance of a salient loop on the grinding surface of the tooth. If, in these respects, as in others, *E. Zulu* and *Loxodonta griqua* are to be looked upon as possible ancestral types leading towards the modern *E. africanus*, it is clear that the absence of such characters removes the possessors of the present teeth still further from any likely relationship with the Loxodonta group as a whole.

Relationship and Systematic Position.

Relative to this question, it is clear in the first place that both teeth—whatever be the decision concerning their separation into two distinct species—are collectively representative of a genus new to southern Africa. Osborn (*Amer. Mus. Novt.*, No. 152, 1924) has indicated within his sub-family Loxodontinæ at least three lines of generic descent, namely:

1. Loxodonta, progressive from unknown ancestors to *L. africanus*.
2. Sivalikia, typified by *L. namadica* Falconer.
3. Pilgrimia, typified by *E. falconeri* Busk.

Meanwhile he confirmed Pohlig's separation of the southern mammoths, *Elephas planifrons*, *E. meridionalis*, and *E. imperator*, into the distinct generic phylum Archidiskodon of the sub-family Mammontinæ.

These two teeth cannot be grouped under any of the three lines of generic descent of the sub-family Loxodontinæ indicated by Osborn, nor, as we have seen, can they be grouped with the Polydiscodonts. Given, however, that laticoronate, short, pachyganal parsilamellate molars such as those of *E. meridionalis* achieved a greater length and became hypselodiscal, we would secure types such as those before us. They may, therefore, be included with those of *E. meridionalis*, *E. planifrons*, and *E. imperator* amongst the southern mammoths in the generic phylum Archidiskodon of the sub-family Mammontinæ.

The importance of this determination will be recognised when it is stated that although the presence of the mastodon has been recorded from South Africa, this is the first evidence of the appearance of the mammoth family south of the equator in the Old World. It is known, of course, that this generic phylum spread east and west even into America and was represented there by a number of species, but hitherto no distinct evidence of their penetration into the Transvaal has been available.

The close relationship between the Loxodonta and the Archidiskodonta is obvious from various points of view, and it is not without scientific interest that Scott should have regarded *E.* (*Loxodonta*) *Zulu* as virtually "intermediate between the Loxodonta and Archidiscodonta." In our present teeth we have undoubted Archidiskodonts, and their relationship to other South African forms is not clear; the recovery of more material would be essential for that. This much is at least plain; they cannot be looked upon as ancestral to the modern Loxodonts, not only because that would have entailed a reduction in tooth size and lamella formula which is not to be expected, but also because we know from Haughton's discovery that the evolution towards the Loxodont enamel pattern was well-advanced in the period indicated by the 60-80 ft. terrace, whereas the Archidiskodont gravel is much more recent. The possessors of these teeth are rather to be looked upon as the last and specialised remnants of a great race already being supplanted by elephant types more appropriate to southern African conditions.

Osborn (*Proc. Amer. Philos. Soc.*, 1925) has finally divided the Proboscidea into sixteen races, of which the family Elephantidæ includes six races as follows:

"Race XI.—The Stegodonts. . . .

"Race XII.—The African Elephants or Loxodonts. . . .

"Race XIII.—The Southern Mammoths or Archidiskodonts. Excessively broad-plated grinders with abundant cement; first known in India, migrating westward into southern Europe, eastward into America, where arriving in late Pliocene or early Pleistocene time they finally gave rise to the Imperial Mammoth, *Archidiskodon imperator*, the last of its race.

"Race XIV.—Parelephas, the north temperate Mammoths. . . .

"Race XV.—The Woolly Mammoths (Mammonteus. . . .

"Race XVI.—The true Elephants (The Elephas of Linnæus)."

It will be recognised that this description of Race XIII. may now be extended to state that they migrated southward across the equator and into extreme southern Africa, where, arriving probably in well-advanced Pleistocene time, they finally gave rise to a perhaps equally massive form of Archidiskodon, probably here also the last of his race, since he is found in the lowest Vaal gravels.

Two Species of Mammoths.

If then we distinguish as *Archidiskodon transvaalensis*, sp. nov., the type specified by the larger tooth, it remains to determine whether there are sufficient distinguishing characteristics between it and the smaller tooth to separate the latter from the former as a further new species in the same generic phylum or race as defined by Osborn.

As neither of the teeth is in position in a jaw, and neither is associated with other skeletal parts, this is a matter of some difficulty, seeing that the sex is unknown, and also that the exact numerical seriation of the teeth is hypothetical, although it is highly probable that both are third molars. Recognising, then, these possible sources of error, it is obvious on detailed examination of the teeth that whereas they have certain generic features already described in common, they present marked divergences from one another in details, which are perfectly obvious in the accompanying photographs (Figs. 6 and 7).

The dimensions of the teeth have been given above, from which it appears that the larger tooth was greater in every dimension. Although the anterior plates are missing, its present length equals that of the other tooth. It is 10 mm. broader and it is 50 mm. higher in its posterior portion. Apart from these points, the whole atmosphere of each tooth is different from that of the other. *From the lateral aspect*, despite its great height, the larger tooth has a massive squarish appearance, markedly different from the triangular form of this aspect in the smaller tooth. The individual plates are obscured in the larger tooth by a dense covering of cement over approximately the entire lower half (115 mm.) of this surface, and almost filling up the interlamellar clefts in the upper half, which are thus rendered broad and shallow. In the smaller tooth the lamellæ are covered with cement over approximately the lower third (60 mm.) only of this surface, and above this point the interlamellar clefts are extremely deep (5-10 mm.) and narrow in appearance. The same features are repeated on the medial aspects of the teeth.

From the grinding aspect, the larger tooth has a more bulging ovoid appearance than the narrower and more ellipsoidal appearance of the smaller tooth, as follows also from their respective length and width measurements. Despite the fact that the total lengths of the two specimens are virtually identical, there are three (and perhaps more) additional lamellæ in the larger than in the smaller tooth. It has already been seen that the individual lamellæ are appreciably wider in the larger than in the smaller tooth, so that the interlamellar cement is more abundant in this tooth than in the former. There are also differences in form between the lamellæ of both teeth, in that the narrower lamellæ are more recurved posteriorly at each end of the lamellæ, and the laminæ of each lamella possess a narrower or finer enamel and are more nearly parallel in the smaller than in the larger tooth.

Differences are also presented posteriorly where the plates are coming into wear. In the larger tooth *five* plates show this transition. The most posterior of the *five* presents in the worn tips of its digitations four oval islands of enamel-encircled dentine. The second has a wear-surface consisting of five islands of enamel-encircled dentine, the third has a wear-surface consisting of a larger median area formed by the fusion of the three central islets, and on either side of this median islet is a smaller islet. In the fourth there are again three islets, but the lateral ones have increased more towards the size of the central islet. In the fifth there are two islets, the central and medial islets having joined together. In front of this one all the plates have one wide islet only, all three being now continuous across the tooth.

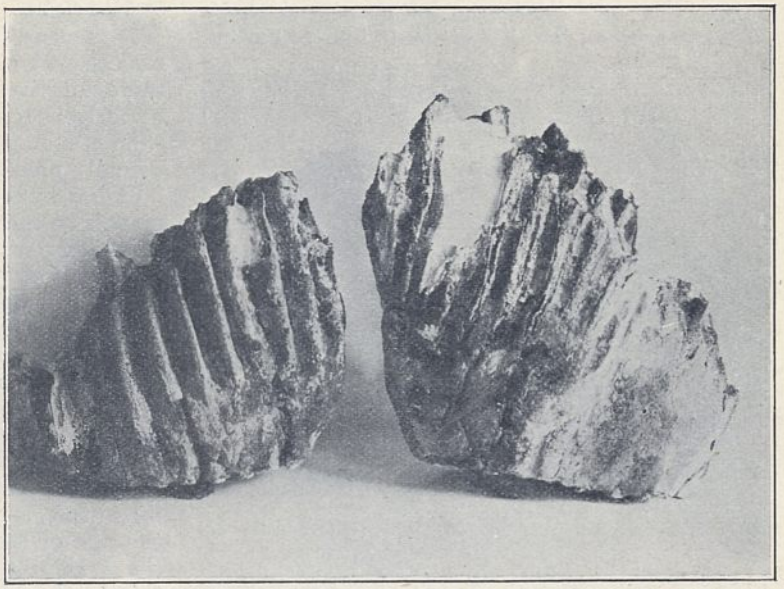

Fig. 6.—Lateral view of mammoth teeth.
Left: *Archidiskodon sheppardi*; right: *Archidiskodon transvaalensis*.

These points with regard to the appearance of the digitations, as they come into wear, are of some interest in that they present in the posterior plate of the tooth a condition of affairs identical with that revealed in an elephant molar described by that distinguished palæontologist, the late C. W. Andrews (*Geological Mag.*, Decade V., vol. 9, No. 573), from a fragment consisting of three posterior plates of an upper molar only. This fragment was found amongst other bones during the construction of a bridge next Khartum, retrieved at depths of 60-68 feet below the level of low Nile. The measurements of our present specimen in its posterior part also practically coincide with those (*w.*—100 mm. *h.*—200 mm.) of Andrews' specimen, save in the height, which in our specimen is appreciably (20 mm.) greater in this situation. I have little doubt

from his clear description that Andrews had at that time in his hands a portion of a tooth of a very closely related, if not an identical, species. Andrews pointed out in his brief note the comparisons that were to be drawn between his fragmentary specimen and *E. meridionalis* and the differences separating it from *E. antiquus*, *E. jolensis*, *E. atlanticus*, *E. Zulu*, and *E. priscus* Falconer. With his characteristic caution he refused to name a new species from a fragmentary specimen, and unfortunately, while recognising that this discovery assists us in appreciating the line of migration southward through Africa of the Archidiskodonts, we are unable to refer the present species to a species already named by him.

In the smaller tooth the pattern presented by the digitations as they come into wear is considerably different, there being only *three* plates showing transition stages from separate digitations to full plates. The most posterior of the three shows three small islets, the second shows four somewhat

FIG. 7.—Grinding aspect of mammoth molars.
Left: *Archidiskodon transvaalensis*; right: *Archidiskodon sheppardi*.

larger islets, and the third one very large medial islet and one small lateral islet. The remainder of the lamellæ form complete single islands across the grinding surface of the tooth.

Whether from a specific point of view it is a matter of importance I do not know, but whereas the grinding surface of the smaller tooth has an evenly convex contour from end to end, the larger tooth, on the other hand, has a voluted surface such as the blade of a propeller, the medial portion of the tooth being longer than the lateral portion posteriorly, and the lateral portion being longer than the medial portion anteriorly. The uneven pattern produced in the islets of this tooth may be due to some curious grinding movement associated with this peculiar pattern of voluted or propeller blade wear, the appearance of which is expressed in some degree in the photographs of this aspect of the teeth.

Sufficient differential characteristics between the teeth have been discussed to indicate that it is highly improbable that they belonged to the same species. Even if we looked upon the smaller tooth as being a second molar from a female, it is scarcely likely that there would be so great a gap between the two. In view, therefore, of the Sheppard brothers' interest in securing the teeth and forwarding them for examination, I will denote the type indicated by this smaller upper and presumably third molar as *Archidiskodon Sheppardi*, sp. nov.

Conclusions.

It is evident, therefore, that the southern mammoths were represented in southern Africa by at least two distinct species of the genus, and that the line of their southerly migration is shown by the recovery of portion of a tooth of a nearly related species from the depth of 60-68 feet below the Nile at Khartum.

It is clear, further, that the southern mammoth replaced here as elsewhere the mastodon genus representatives, but that they were assisted in this by early representatives of the Loxodont group, who were contemporaneous with them, if they did not actually precede them in this part of the country.

It has been shown that the lowest or *mammoth* gravels of the Vaal bed are replete with evidences of the lower palæolithic type of culture. They are therefore presumably pre-Bushman in orientation. The only pre-Bushman type known from extreme southern Africa so far is Boskop man. Containing, as they do, extinct forms of mammalian life, there is presumptive evidence furnished that these gravels will yet supply this, and perhaps other hitherto unidentified forms of human-kind, and show them to have been responsible for that culture.

The recognition of extinct forms of mammalian life in the gravels of the river bed further enhances the age of the 60-80 ft. or *mastodon* terrace, and the evidences of palæolithic culture secured from this level and described by Hodkinson. The expectation of human remains there of great importance phylogenetically cannot be exaggerated, since this *mastodon* bed must reach back to a rather early phase of the Pleistocene.

The 200-300 ft. terrace and any fossil mammalian remains or evidences of human culture at that level, which would appear to approximate if not actually to be situate entirely within the Pliocene, must be of premier anthropological importance. It may be that the next visit of the British Association in 1929 will aid in bringing to fruition the seed sown by its coming to the country some twenty years ago.

In conclusion, I desire to express my gratitude to Mr. J. C. Middleton Shaw for his assistance in the problem of determining the systematic position of the remains; to Mr. Austin Roberts for his help in the examination of elephant teeth at the Pretoria Museum; and to Dr. A. W. Rogers and Dr. S. H. Haughton for literature and general information which they have so liberally afforded. The photographs have been prepared by Mr. R. A. Krynauw, and the diagrams by Mr. E. A. Thomas, of the Medical School of the University of the Witwatersrand.

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