NATURE

SATURDAY, SEPTEMBER 11, 1926.

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Editorial and Publishing Offices:
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON.

NO. 2967, VOL. 118]

Evolutionary Physiology.

THE presidential address to Section I (Physiology) delivered by Prof. Leathes at the recent meeting of the British Association in Oxford was so remarkable in its width of view that it may be said to constitute a landmark amongst such addresses. In the past the main objects of physiological research have seemed to be two: first, to investigate the chemical nature of the substances which enter into living matter, or perhaps it would be better to say recently killed matter, and secondly, to invent imaginary machines which in their working would resemble the functions of living beings. But even if the second object were completely attained (and in no single case has this been done) it would still leave unanswered, as Sir Charles Sherrington has pointed out, two fundamental questions—namely, first, how such machines are built up out of the formless protoplasm of the egg, and secondly, how mind inserts itself in matter. Leaving the second question aside as too profound to discuss even in the pages of NATURE, we may note that Prof. Leathes boldly grapples with the first: he discusses the nature of life itself, as well as the chemical nature of the substances with which it deals.

The first and most obvious explanation of the phenomena of life which suggests itself is that these peculiarities are due to the chemical nature of the compounds which enter into protoplasm. These Prof. Leathes classifies as proteins, nucleic acid, lipoids (compounds of the higher fatty acids), and sterrols. The proteins have been shown to be long chains of as many as 100 links, each link consisting of an amino-acid. As all chemists are aware, these acids have, as their name implies, a basic as well as an acid 'hand'; and they owe their ability to form chains to the fact that each with its basic hand can grasp the acid hand of its neighbour. But, as Prof. Leathes tells us, there are only about twenty amino-acids known, and the infinite variety of proteins must be due to the order and number of the links which are put together. In this order lies one of the fundamental secrets of life, namely, that of assimilation. Modern research on digestion seems to show that the organism does not incorporate ready-made blocks of protein into its structure, but first of all breaks up these blocks into their constituent amino-acids and then mysteriously reassembles them in its own proper order. The analogy of a crystal segregating from its mother-liquor will not help: in this case we have to do with a rigid framework of similar atoms, bound together in a solid, and life is only manifested in a fluid medium. In a crystal, moreover, the particles which are added to the crystal face are similar to those already constituting it and previously exist as such in the liquid, but

in the formation of protein chains a varied assortment of amino-acids is added according to a definite scheme. To build up the chain by the elimination of the elements of a molecule of water as each link is fastened to the next requires the expenditure of energy. This energy is supplied either by the radiant energy of the sun or by the oxidation of some other compound.

The mystery of life is not the creation of energy; it is essentially, as Prof. Driesch put it in a forceful address delivered this year, in London, the 'control' of energy—the control which out of a chaotic assemblage of materials whirling about in the fluid builds up a definite specific structure. The word 'regulation' coined by Driesch about 1895 to denote the mode of activity of his 'entelechy' and abhorred by the mechanistic school of which the late Prof. Loeb was the principal ornament and exponent, is creeping back into the vocabulary of experimental embryologists like Spemann and von Uebisch because the facts with which they deal will allow of no other explanation. The number of possible permutations of the order of the links in these protein chains is almost infinite, so that, as we have seen, the structure of the unfinished chain discloses no necessity of giving rise to a completed chain of a particular kind. Prof. Leathes speculates as to whether an occasional 'permutation' in this order may not be the cause of what biologists term a mutation. It is greatly to be desired that this word 'mutation' should either be rigidly defined or else removed from the scientific vocabulary altogether. Sometimes it is used to denote any change whatever in the hereditary potentialities of an organism, and then to say that evolution is explained by occurrence of 'mutations' is merely a truism. But the fact that this is a truism is often illegitimately employed to support another theory, namely, that violent and sudden divergences from type such as Prof. Morgan encounters in his cultures of Drosophila, and which form the 'sports' familiar to every breeder and gardener, constitute the raw material of evolution.

All the evidence at our disposal is hostile to such a suggestion: these 'mutations,' though they are certainly hereditary, are all characterised by weakened vitality and are unable to hold their own in the struggle for existence. This fact has been ably expounded in the address to Section D given by Prof. Osborn and printed in NATURE of August 21, who, in order to emphasise the view that the changes by which animals evolve are widely different from mutations, introduces the word 'speciation.' Further, as Prof. Leathes wisely says, a mutation is not eternal. This, indeed, is its most interesting characteristic; the sport transferred to a natural environment, where, in the absence of dangerous competitors, it has a chance to survive, will after a certain number of generations revert to type; like the feral pigs of Jamaica, which have gone back to the wild boar. We submit that the cause of a mutation is to be sought in the weakening or inhibition of one of the processes which make up the activity of the germ plasm, a weakening which under better conditions is transmitted to succeeding generations in ever-lessening degree and eventually disappears.

Prof. Leathes eloquently discourses on the relation of function to structure and rightly states that physiologists who study function are well fitted to make contributions to the doctrine of evolution. What is 'functional' survives, and structure is the expression of function. This is shown by the fact that the same type of cell, the fibroblast, or, as embryologists term it, the mesenchyme cell, will develop connective tissue fibres and give rise to tendon at the end of a muscle, and will form and deposit calcium phosphate where bone is required. Every particle of bone, he asserts, is the response of the organism to the strains which the exercise of its members brings about. These products of cell-secretion he terms irreversible, as opposed to the reversible changes which take place in muscle.

The difference, however, is after all only one of degree. Cary has shown that muscular fibrils are developed in mesenchyme cells under the influence of strain. In the embryo pig the gut-tube grows faster than its mesenchyme envelope, and the development of these cells into smooth muscles takes place in accordance with the elastic tension to which they are exposed, and, on the other hand, are not the osteoclasts which remove superfluous bone essentially identical with the osteoblasts which deposit it where it is required?

The fact is that the early exponents of evolution, being naturalists and morphologists, had only a superficial knowledge of function, and any structure the meaning of which was not obvious was ascribed to 'chance' variations which 'happened' to suit the environment. An example of this method of reasoning was the explanation of the dark pigmented spots found on the forehead of certain carnivora as devices intended to deceive their enemies into the delusion that the animal whilst asleep was really awake and gazing at them. As our knowledge of comparative physiology has progressed it has become more and more obvious that the whole body of the animal is an expression of its functions; or, as a zoologist would phrase it, of its reactions to its environment.

That the functions of cells are reactions to their environment was demonstrated in a beautiful way by Nageotte. He took a piece of sterilised bone from a rabbit's digit and implanted it in the cartilage of the ear. The introduced bone was soon surrounded by

'fibroblasts' drawn from the neighbouring fibro-cartilage and connective tissue. These invaded it and actually deposited new bone around it, although in the normal course of affairs these cells never would form bone.

Prof. Leathes also discusses 'the conditioned reflex.' This is most simply described as a new association of ideas, though Prof. Leathes interprets it as the establishment of a new machinery in the nervous system. The classical example is, of course, Pavlov's wonderful work on the dog, in which the animal was made to associate the sound of a bell with the arrival of food. As a consequence copious secretion of saliva was produced by the sound of the bell. Koffka in his book "The Growth of the Mind" has shown how powerless is the conception of fixed reflex arcs when examined in detail to explain the formation of the new associations. Leaving this special difficulty on one side, however, Prof. Leathes truly remarks that the establishment of new functional relations is only of importance in evolution if this rise of new functions—in a word, the acquisition of new habits in the parent—affects the offspring so that the establishment of the same functional relations in them is effected more and more easily as the generations succeed one another. As most people are aware, this is at once the most fundamental and at the same time the most hotly disputed question in biology. Pavlov has asserted that he has demonstrated, by his experiments on mice, that conditioned reflexes in parents do affect the children. These results have been received by the supporters of 'chance variations' with the same incredulity with which they have received other similar results obtained by investigators of less world-wide fame than Pavlov. Prof. Leathes, as an impartial outsider, whilst awaiting confirmation by Pavlov himself of his own preliminary work, seeks to conciliate the more violent opponents by the use of the phrase 'parallel induction.'

By this phrase is meant the theory that whilst the body is incapable of affecting the germ cells which are embedded in it, yet an external influence may at one and the same time affect the body so as to provoke a new reaction and thus initiate a new structural change, and also affect the germ cells so that the next generation will show the same structural change. Surely this theory may aptly be described as the last ditch in which the opponents of the inheritability of acquired habits are prepared to die. Can it be seriously maintained that external changes in light and temperature can penetrate the somatic tissues and alter the deeply-seated germ cells, and yet that the body, which is in close physiological relation to these cells, is powerless to affect them?

Prof. Leathes makes a striking reference to the coincidence of the rediscovery of Mendel's laws of segregation in the hybrid offspring of different breeds, and the cytological discovery of the coming together of paternal and maternal chromosomes in the maturation of the germ cells and their subsequent disjunction into different cells. This 'meiosis' has been widely accepted as the physical basis of this segregation, and it is an hypothesis of seductive simplicity to take this view. But the whole history of physiology ought to warn Prof. Leathes of the peril of accepting simple mechanical explanations such as these. Again and again physiologists have believed themselves to be on the verge of simple physical explanations of vital functions, such as the diffusion of water from the blood through the glomerulus of the kidney, or the passage of oxygen through the alveolus of the lung, and each time closer examination has proved how disappointing and illusory such explanations are. In that wonderful school of cytological and Mendelian research established by the late Dr. Bateson in the John Innes Horticultural Research Institution, a body of devoted students have been studying Mendelian problems for years, and Miss Sverdrup's discovery that there are nine sets of independently segregating characters in the pea, but only seven chromosomes, is a result of just the same kind as physiologists have obtained in other fields.

In conclusion we may say that Prof. Leathes' eloquent appeal to his fellow physiologists to study functional evolution has our warmest sympathy. We feel convinced that if they respond to this appeal the whole aspect of evolutionary philosophy will be enormously changed and improved.

The Assaying of Brabantius.

The Assaying of Brabantius and other Verse. By C. S. Sherrington. Pp. iv+67. (London: Oxford University Press, 1925.) 4*s.* 6*d.* net.

THIS book of poems should interest all lovers of literature, not merely because of its author's eminence in the scientific world, but also for its own artistic quality. It contains the most accomplished verse that has been published in England by any man of science; and one of the most remarkable facts about it is that the point of view throughout is purely artistic. The poem on Keats, for example, is a poem of joy in the artistic handling of words. It shows them "in music swayed attire," shadows moved by the fire of thought. It shows them as "raised trumpets blown at morn," or as "foamed sea-capes calling through mist." It does not talk philology, but it finds them "still across this day of ours weaving fancy's storied woof."

The philistine who prides himself on his superiority

to 'words' and on his inability to express his own ideas has conquered a large section of the literary world in recent years. Under a new disguise, as the advocate of a crude realism, and the opponent of what he calls 'rhetoric,' he has succeeded in convincing the thoughtless sections of the public that the incomparable language used by the rhetorical author of "Paradise Lost," with its infinitely subtle lights and shades, is less vividly expressive and less full in content than the broken-down jargon of the streets. Violence, the schoolboy use of the most conventional 'scarlet words,' is mistaken for strength, while the true use of language as an exquisite intellectual instrument, capable of the most precise expression of the subtlest ideas, is mistaken for smooth insipidity or what lisping school-girls now call, under the influence of weak-minded newspaper-ridden teachers, 'lack of guts.'

We are living, artistically, in an Aristophanic comedy. Prof. Ward in his really profound "Pluralism and the Realm of Ends" draws largely on Tennyson to elucidate some of the subtlest philosophical ideas of modern times. At the same moment a child of sixteen, quite unaware of any of those ideas, announced to her friends in Chicago lately, "I cannot wead Tennyson. He is so tewwibbly twite. But there's a poem in the *Little Weview* this month which I simply adore. It's so wed-blooded. It's about a bwothel." This is an extreme case; but it is a perfect illustration of the ignorance and conceit which have been allowed to mislead the arts, during the last decade or two, into the insane chaos where so much of the recent work has been floundering. It seems possible that if merely literary criticism cannot save the arts from self-destruction, the scientific mind may have to come over and help them, in the interests of our civilisation, with a little cool lucidity, and a few elementary lessons in rhythm, order, proportion, symmetry, and all that these things imply. When first principles go into the melting pot we may even have to re-demonstrate to our æsthetic agnostics that twice one is two. But science and art have one great common ground, in the ultimate unity of beauty and truth. That ground has never yet been fully charted or explored. The day may come when the golden mathematics of music, in its ascensions to heaven, and its unexpected opening of celestial gates, may unlock some of the most baffling problems of philosophy. Even now, when philosophical terms fail us, we can point to certain movements in a Beethoven symphony and say, "There—that is what I mean," not as an emotional, but as a logical solution. In the meantime it is all to the good that Sir Charles Sherrington in his lines on Keats appreciates so justly the æsthetic values of language. Words, to him, are not mere lifeless counters or labels, but creatures of the heart and mind of man, evolved through ages and having messages of "heavenly things to tell":

> Words, deliverance of joy,
> Words, blithe feet that move in dance,
> Flute-throat words of girl and boy
> Pœaning the spring's advance,
> Weeting death not nor mischance;
>
> Words, heaped torrents swollen with rain,
> Words, cloud voices league-long blown,
> Words, begotten of human pain
> Grief-matured through nights of moan;
> Words like bell-towers sobbing in stone.

Art, as I suggested above, has its chaos; but philosophy has certainly its confusions. There is no precision of expression like the precision of great poetry. Modern thought would have been a century ahead of its present stage if certain famous philosophers had been able to express their ideas with the profound lucidity of Wordsworth's "Tintern Abbey." Sir Charles Sherrington's own verse has not that limpid depth. He is often a little wilfully tortuous and so he deliberately limits its effectiveness. But he strikes many chords that linger in the memory, and in his enthusiasm for great poetry his book is of real value to both science and literature.

> The great dead—not they lie dumb,
> Nor are their lips stopped with clay.
> Listening fresh to their graves come
> All the new-born every day.
> We that breathe speak less than they.

There are many glowing pictures in the narrative poem entitled "The Assaying of Brabantius," of which perhaps the most immediately striking is the description of the sea-robbers' attack upon the lordly pleasure-house wherein Brabantius was losing his soul:

> Where throngs
> Of slaves flowed dancewise and made songs
> To please the fanswept dwellers there
> Pavilioned over perfumed air.
> And how upon them broke a day
> Brought, trespassing their sun-caped bay,
> Fierce urgéd purple hulls of ships
> With tumult filled from brine-caked lips,
> And ear-ringed robbers little loath
> Shook loose their knives, and, hoarse with oath,
> O'erleaping row-bank, thwart and oar,
> The beaked keels grounding, swarmed ashore
> To clamber up the milky flights
> Of graded marbles, till the heights
> They won, and swept the pillared shade
> Of court and dome and colonnade,
> And slew, nor in their slaying stayed
> Till all the dazzling streets bereft
> Of life they left, and pool-strewn left
> As market-stones are with wine lees
> With blood the burnished terraces.

The influence of William Morris will perhaps be discerned in this. Here, as elsewhere, the remarkable fact is that there is scarcely a sign anywhere in the book that the author is interested in anything but his art. He never touches upon any scientific subject. But the scientific quality of his mind is revealed in the analysis of character in the "Assaying of Brabantius," which is certainly different from anything in William Morris, and more modern in feeling. It shows itself also in the sonnet entitled "Speech":

> And thus accomplished, after lapse of time,
> Dear meed of converse binds life's scattered ones,
> With healing of the schism of old prime
> As light rejoins the pulses of old suns.

Fragmentary quotation, however, is unjust to the book. It emphasises the somewhat deliberate archaism, and the twisted phrasing. Twisted though it be, it is artistically twisted, and there is a gleam of beauty on almost every page. The sonnet on Oxford is one that none of her sons and lovers who read it will easily forget:

> The night is fallen and still thou speakst to me,
> What though with one voice sole, with accents many,
> Tongued turret and tongued stream, tracked pasture fenny,
> And cloister spirit-trod, and centuried tree;
> And, bondsmen loosed in Time's tranquillity,
> Thy bell-dischargéd hours . . .
> And now, below, through shadows starred, a boat
> Steals by me laden with singing and young laughter
> And, higher, a wide-flung casement casts afloat
> Pulses of waltz the which white robes sway after;
> Sworn Priest of Beauty, these thy shrines among,
> That kneelst with old folk and that dancest with young.

ALFRED NOYES.

The Atom Again.

(1) *The Basis of Modern Atomic Theory.* By C. H. Douglas Clark. Pp. xx+292. (London: Methuen and Co., Ltd., 1926.) 8*s.* 6*d.* net.

(2) *Die Konstitution der chemischen Atome: Mechanische Theorien in Physik und Chemie.* Von Prof. Dr. Arthur Korn. Pp. 159. (Berlin: Georg Siemens, 1926.) 7·50 gold marks.

WHATEVER properties may ultimately be assigned to the atom, there is one which cannot be omitted—its power to seize and captivate the human mind. In fact, if we judged by the output of the printing press in the last few years, we might not unfairly assume that no sooner does any one fall within the sphere of influence of this radiating personality than he is seized with an irresistible determination to go home and write a book about it. Nor is this proselytising zeal confined to the pure physicist, whose protégé the atom may be presumed to be. We have books on the atom, some of them quite well done, by chemists, by mathematicians, by technicians, and by journalists, and addressed to all sorts and conditions of readers. Thus we have "Atoms for Amateurs," "Atoms for Adepts," "Atoms for Adolescents," "Atoms for Archdeacons," "All about Atoms for Anybody"—these are not the exact titles, but they indicate the scope of the volumes well enough—in fact, there seems to be a determination that no class of reader shall be left without an exposition of the subject suited to his condition and attainments. As these volumes continue to pour forth—there are two fresh ones before us as we write—we must assume that they find purchasers and readers. If we add to these the enormous output of serious scientific contributions from the many laboratories engaged in investigating the structure and properties of the atom, it is clear that this infinitesimal particle exerts an attraction unique in the history of science over the minds and imaginations of many types of men.

These reflections have been induced by the almost simultaneous appearance of the two volumes the titles of which are given at the head of this review. These differ in almost every conceivable way. One is in English, and is by a lecturer in chemistry; the other, in German, by a professor in a technical institute. One is a compilation involving an enormous amount of reading and abstracting; the other is an account of the author's highly individual speculations. They have only one thing in common. Both authors have been seized and fascinated by the subject, and cannot rest until they have expressed their enthusiasm in print. This, after all, is the only legitimate excuse for writing a book.

(1) Mr. Clark, in his enthusiasm, has read omnivorously and abstracted widely. In 282 pages he makes a clean sweep of the subject from Lucretius to Bohr, Sommerfeld and Debye. There can scarcely be any paper dealing with the atom which Mr. Clark has not consulted, and very few of which he does not make some mention. To have condensed so much into so small a space is a miracle of compression, and his difficulties have been increased by the fact that, as a chemist, he has thought it necessary to devote an appreciable part of his volume to the theories of Langmuir, Lewis, and the physical chemists which a physicist, straitened for space, would probably have been content to treat in a much more summary manner

It has evidently been the author's aim to include some reference to everything which has been either thought or discovered about the atom. To give anything like an adequate account of the subjects

touched upon in this book would require many volumes of equal size, and the author's treatment of the different parts of the subject is necessarily very brief and summary. We must confess to a personal prejudice against the author who skims lightly from flower to flower without extracting the last drop of nectar from each, and quotes formulæ without giving an adequate notion of the steps by which they are derived. For us, not only the chief value but also the main pleasure of science lies in the process rather than in the product, and we were inclined at first sight to regard Mr. Clark's book as falling under the ban of superficiality.

A closer reading, however, convinces us that the book performs a very useful piece of service. In geography we have original books of travel which give us minute accounts of various peoples and places; we have text-books, more or less voluminous, which give abstracted accounts of larger areas; and finally we have the atlas and gazetteer, which is content to tell us what places there are, and where to look for them; and each type of work has its uses. Mr. Clark has provided us with a gazetteer to the atom, and on turning over its pages one realises how much such a gazetteer is needed for this vast and ever-expanding tract of human knowledge. From this point of view the book is excellent. The student who uses it, and any one who is working on atomic physics may be recommended to do so, will find it a mine of information as to what there is to be known about the subject, while admirable lists of references and two good indexes will tell him precisely where to look for the information required. When next we are troubled by vague memories of a paper in some forgotten journal, by an author whose name we cannot for the moment recall and containing results which were probably important if we could only remember what they were, we shall certainly turn to Mr. Clark's book for assistance, and, if the paper has any reference to the atom, we shall not turn in vain.

We cannot congratulate the publishers on their share of the production. We recognise, with regret, that we cannot expect very many pages of print for 8*s*. 6*d*., and in this respect the publishers have not been ungenerous. The artificial increase in the mere bulk of the volume, produced by printing it on absorbent paper and appending a catalogue of general literature, adds nothing to our sense of its value, and does detract very materially from its appearance. The binding is poor and unattractive. The text is good enough to deserve a better dress.

(2) Dr. Korn's book differs widely in its purpose from the one we have just been considering. Whereas Mr. Clark records, almost without comment or criticism, the diverse views which are still current on atomic constitution, Dr. Korn's purpose is to develop and to popularise a highly individual theory of his own. He feels that his theory, as expounded in various papers in the *Physikalische Zeitschrift* and elsewhere, has not received the attention it merits; and surmising that this may be due to its highly mathematical form, he presents his views, in the present volume, in a way which he thinks will be within the capacity of physicists to apprehend. It is clearly outside the province of a book review to criticise original work of this kind. In brief, Dr. Korn proposes to add to the positive and negative particles which are known to be present in the atom, a third class of particles, gravitating particles, the existence of which has not yet been demonstrated experimentally. He then modifies the law of force between the particles by introducing an exponential term into the Coulomb law of force, and on these assumptions builds up a series of atomic structures the properties of which approximate, with some considerable degree of precision, to the properties of the known elements.

We think that physicists are more likely to be deterred from accepting Dr. Korn's theory by his assumptions than by his mathematics. The quantum theory in its applications to the Rutherford-Bohr atom is flowing on in a full current which shows no signs of abating. Unless and until it meets with some unexpected and quite unsurmountable obstacle, it is unlikely that the main stream of atomic science will turn back to flow along the alternative channel which Dr. Korn provides. Physicists, however, who wish to investigate this channel for themselves will find the theory excellently and fully expounded in Dr. Korn's book. J. A. CROWTHER.

Aurora Polaris.

Australasian Antarctic Expedition, 1911–14. Scientific Reports, Series B, Vol. 2, Part 1. *Records of the Aurora Polaris.* By Sir Douglas Mawson. Pp. 191+6 plates. (Sydney, N.S.W.: Alfred James Kent, 1925.) 15*s*.

IN view of the connexion between ionisation in the upper atmosphere and the propagation of radio waves, special interest is likely to be taken at present in observations of the aurora and related phenomena, particularly in the regions where the aurora and associated ionisation are most strongly developed. The records of the aurora polaris from the Australasian Antarctic Expedition present the detailed observations from the three stations occupied by that Expedition between 1911 and 1914, and will be followed by two other parts in the same volume—" Records of Magnetic

Disturbances" and "Records of the Range of Transmission of Wireless Signals."

All three stations were situated fairly close to the southern auroral zone, a belt about the magnetic axis of the earth, but at some distance from it, in which auroral display is very frequent. Two of the stations were situated on the Antarctic coast and lay within the zone; the third, on Macquarie Island, lay outside it. Observations at Cape Denison (the main headquarters in lat. 67° 00′ S., long. 142° 40′ E.) were far more complete than at Macquarie Island (lat. 54° 30′ S., long. 158° 57′ E.) or at Queen Mary Land (lat. 66° 20′ S., long. 95° 02′ E.), which formed the western base of the Expedition. When combined with the results of previous expeditions, consideration of the azimuths in which the aurora was most frequently and least frequently observed from the different stations enables one to fix approximately the point of intersection of the magnetic axis with the surface of the earth in the southern hemisphere. This point lies, roughly, half-way between Cape Denison and the geographical south pole.

The visual observations of the aurora at the Cape Denison station are the most complete of their kind for any Antarctic observatory. The programme could not, however, be carried out as planned, since unfavourable weather rendered impossible the proposed photographic determination of the height of the aurora. The general sequence of events is what might be expected at a station lying a little within the auroral zone. The aurora is most frequently seen in the northern quadrants and least frequently in the southern. The normal quiet day sequence comprises a series of approaches from the north and retreats from the station, the aurora often passing overhead in the early morning, though the late afternoon is also favoured by the appearance of aurora near the zenith. During auroral storm periods, greater light intensity is accompanied by more vivid coloration and greater movement.

The most spectacular effects (the "intensity maximum") occur, however, shortly before midnight, at which time the aurora may pass to the south of the station. After the maximum southerly extension, the curtains may wane and retreat to the north, or rapidly spread in the heavens as a sheet of brilliant nebula. These very bright manifestations appear to be special phenomena superposed on the normal quiet day cycle, and it is worthy of note that certain short magnetic storms of "special type"[1] seemed also to be unusual phenomena occurring chiefly in the winter months and always very close to the time of the auroral intensity maximum at Cape Evans.

The local mean time of the intensity maximum differs at the various Antarctic stations and seems to occur, as in the north, shortly before local magnetic midnight, defined as the time when the station, the magnetic axis of the earth, and the sun all lie in the same plane. This relation is not indicated for the Queen Mary Land station, where, however, the observations were not so complete as elsewhere. Observations at the Macquarie Island station lying outside the auroral zone were also less complete than those at Cape Denison, but sufficient to show that strongly coloured displays were more marked at this station than at the others and often persisted for a long time.

Though the statistical method used is the only one adapted to bring out clearly the relative frequency of the aurora at different times of the day and its distribution in azimuth, an exceptional similarity in form is sometimes observed at the same time on successive days. These repetitions of form are much more striking than the repetitions occasionally observed on magnetograph traces, as indeed seems reasonable, since the magnetic disturbances are probably closely correlated with the *average* intensity of display in the auroral zone. This circumstance is probably in some measure responsible for the fact that the correlation between auroral activity and magnetic disturbance found by the British (*Terra Nova*) Antarctic Expedition was not more pronounced.

Special attention was paid by Sir Douglas Mawson to the observation at Cape Denison of the trend or orientation of the relatively straight auroral bands (arches) when near the zenith, which are a special feature of the early morning quiet day maximum. These were found to show a definite anti-clockwise rotation, a movement which may conveniently be expressed by the statement that the arches pointed roughly towards the sun during the dark hours when observation was possible. Probably, however, chief interest will be taken in the section of the report which deals with the observations of very faint auroral phenomena in the form of haze patches and arches. These very faint manifestations were quite impossible of discernment until the eye became fully accommodated to the dark, and could only then be seen by the most acute of the observers. They were seen to maintain themselves for many minutes and often for several hours, waxing and waning in intensity. The report does not, however, indicate what criteria were applied to distinguish these faint auroral effects from the night luminous clouds which have been observed elsewhere at a height of about 80 km.

Careful perusal of the report will probably leave the reader with the feeling that our knowledge of the aurora in high latitudes is still very incomplete and that, even in the field of investigation covered by the

[1] "British (*Terra Nova*) Antarctic Expedition, 1910–13"; "Terrestrial Magnetism," p. 270; "Observations on the Aurora," p. 34.

expedition, there is much which requires further study. The occurrence of the very faint phenomena is a case in point. The anomalous behaviour of the aurora at the Queen Mary Land station furnishes another example, the fairly even distribution of the aurora in different azimuths at this station being difficult to explain in view of the relative infrequency of its occurrence in the zenith.

The enhancement of the diurnal variation in the magnetic elements in high latitudes on disturbed days during the winter indicates an associated ionisation comparable with that due to sunlight, and there seems no doubt that this ionisation is responsible for the interesting correlations between auroral and magnetic activity. Whether any effective correlation exists also between auroral activity and radio transmission in and across the polar regions is not known, but the promised Part 3 of the present volume should throw some light on this question.

Quite apart from these interesting correlations and the laboratory work in progress to determine the properties of the radiations responsible for the aurora and the constitution and form of matter which emits the auroral light in the upper atmosphere, an immense amount of research is still required to clear up the position. More determinations of height and more spectroscopic observations, particularly at great heights, are required at widely separated places and especially in the Antarctic. More work is necessary to determine the cause of the occurrence of unusual colours during unusually active displays and to determine the wave-lengths of the weaker lines of the spectrum and their relative intensities. The relation between the light of the night sky and the occurrence of the auroral green line seems to demand further investigation, as also the fact that the polar aurora appears nearer the magnetic axis of the earth in storm periods, while the occurrence of an aurora in low latitudes is on occasions of world-wide magnetic disturbance.

This list of problems is only a small selection from a very large number which require investigation before the accepted outline theory of the origin of aurora can usefully be elaborated.

Our Bookshelf.

Fourfold Geometry: being the Elementary Geometry of the Four-Dimensional World. By David Beveridge Mair. Pp. viii+183. (London: Methuen and Co., Ltd., 1926.) 8*s*. 6*d*. net.

MR. MAIR states clearly in his preface the scope of his book, which deals essentially with the elementary geometry of a four-dimensional continuum of space and time, the existence of straight lines being assumed. His aim is to prepare the ground for an understanding of relativity geometry rather than to treat his subject as a special case of general manifold geometry. The terminology is evidently chosen from this point of view, and the distinction between 'time-like' and 'space-like' vectors is made early in the book and used throughout.

The author begins with an account of the line vector from which he builds the area, volume and super-volume vectors. He explains geometrically his frames of reference or lattices in two, three, and four dimensions in turn, deals with combination of vectors, defines the tensor operator and establishes the invariants for transformation of lattices. As examples he discusses the velocity vector, derives the Lorentz transformation and gives a brief account of the motion of a particle. One feels, however, that these results are not so much illustrations as part of the scheme of the book.

From the first the notation is carefully explained and chosen to foreshadow and fit the tensor operations which thus emerge naturally and easily. The style is lucid and precise. Such terms as 'perpendicularity' and 'parallelism,' for which new definitions are needed, are treated with admirable clearness. The dependence of results upon the straight line hypothesis is emphasised, and it is shown how the removal of this restriction leads to the wider problems of the curved fourfold, which, as Mr. Mair points out, are beyond the scope of the book, although he indicates the use of the geodesic. The idea of invariance for different lattices is well stressed so that the reader cannot fail to realise its importance. A knowledge of Cartesian geometry is assumed, but very little more. The careful diagrams and well-thought-out exercises interspersed in the text, together with solutions at the end, add to the value of this stimulating little book.

Essentials of Systematic Pomology. By Prof. Brooks D. Drain. (The Wiley Agricultural Series.) Pp. v+284. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1925.) 13*s*. 6*d*. net.

THE increasing number of varieties of fruit and the uncertainties of commercial nomenclature render the study of pomology full of pitfalls, and the student and grower alike will welcome Prof. Drain's attempt to set forth the essentials of the subject in a lucid style, shorn of unnecessary detail. Though dealing with American conditions, the text-book should prove of value to workers in other countries also. In studying the principal varieties of hard and soft fruits the various points are tabulated into good and bad characters, with notes on distribution and extent of cultivation. Various keys for the classification of apples are considered, that of Carpenter and Stafford being regarded as the best, Shaw's key for leaves and Keil's group classification of the fruit also finding a place. Of special interest are the sections on fruit exhibition and judging, details of American rules being given with the appropriate methods of scoring points. Exercises for class work are suggested, with practical hints on the cold storage of soft fruits for examination at later dates. A glossary of pomological terms and a certain number of references are included.

The development of fruit varieties in North America has been closely connected with the settlement and

development of the country. The early explorers and settlers brought in varieties of fruit from their native lands, many of which successfully passed through a period of acclimatisation. Selection and breeding from these old stocks have resulted in the production of new varieties better adapted to the needs of the growing fruit industry. Inevitably, increasing confusion of nomenclature has resulted, and therefore the American Pomological Society has drawn up a code of fruit nomenclature, in an endeavour to simplify matters. This code has been considered as the final umpire since about 1865, the last revision of 1923 being that now in use. W. E. B.

Grundzüge der Paläontologie (Paläozoologie). Von Karl A. von Zittel. Neubearbeitet von Prof. Dr. Ferdinand Broili und Dr. M. Schlosser. Abteilung 1: *Invertebrata.* Sechste verbesserte und vermehrte Auflage. Pp. viii + 733. 17 gold marks. Abteilung 2: *Vertebrata.* Vierte vermehrte und verbesserte Auflage. Pp. v + 706. 15 gold marks. (München und Berlin: R. Oldenbourg, 1923–24.)

BOTH geologists and zoologists are much indebted to Prof. Broili, of Munich, and the enterprising publishers of Zittel's "Elements of Palæontology," for a rapid succession of new editions of this indispensable handbook, keeping it up-to-date. It is a compendium of facts, with references to the scattered literature of the subject, such as are needed for research in many directions, and the arrangement of the matter, as originally planned by Zittel, makes it easily used. It still tends to be conservative in admitting new hypotheses or schemes of classification, and most of the additional figures resemble those of the first edition in being actual illustrations of fossils rather than explanatory sketches. The work indeed retains all the essential features of Zittel's incomparable exposition.

In the sixth edition of the section on Invertebrata the mollusca have been particularly revised with the aid of Prof. A. Naef and Dr. J. Schröder. In the fourth edition of the section on Vertebrata, the mammals, birds, and fishes have been revised entirely by Dr. Max Schlosser. Prof. Broili has thus supplemented his own labours by securing the co-operation of other well-known specialists, and the result is an encyclopædic work which inspires confidence. There are more small misprints than should appear in technical statements that are so carefully edited; and the additions sometimes necessitate changes which are not attended to in the context. Until, however, another Zittel arises to re-write the whole from the beginning, the minor blemishes incidental to patchwork cannot be avoided.

The Natural History of the Oxford District. Contributions edited by Comdr. James J. Walker. Presented to the Members of the British Association for the Advancement of Science, Oxford Meeting, 1926. Pp. viii + 336. (London: Oxford University Press, 1926.) 10*s.* net.

IT was to be expected that the natural history of the country immediately surrounding a great and ancient university would have been studied with especial thoroughness. None the less, the naturalists attending the Oxford meeting of the British Association must have been impressed with the richness and variety of the plant and animal life and with the great geological interest of the district, as revealed in this handbook. The very abundance of the material at their disposal must have added to the difficulties of the task which the editor and his fellow-contributors set themselves and discharged with such conspicuous success. The volume consists of more than twenty short articles by authorities on their respective subjects. It opens appropriately with sketches of the physical history of the land forms and various other aspects of local geology. These are followed by accounts of the botany of the Upper Thames, and of the birds, insects, and other animals of the Oxford district. The final chapters deal with the entomological treasures in the Hope Department of the University Museum, the wonderful ethnological series in the Pitt-Rivers Museum, and the fine collection of early scientific instruments formed by Dr. Lewis Evans and housed in the Old Ashmolean Museum. The handbook constitutes a summary, and provides a record of local species, which will be of permanent value to such members of the University as are interested in biological studies, as well as to naturalists generally. It is perhaps permissible to suggest that, for the immediate purpose of its compilation, something a little less technical in style might have had an even wider appeal.

Clouds and Weather Phenomena: for Artists and other Lovers of Nature. By C. J. P. Cave. Pp. x + 31 + 23 plates. (Cambridge: At the University Press, 1926.) 5*s.* net.

FOURTEEN years ago, the Cambridge University Press published a book by Mr. Cave on "The Structure of the Atmosphere in Clear Weather," a well-known work on upper winds written by a meteorologist for meteorologists. "Clouds and Weather Phenomena," which is also published by the Cambridge Press, is of a very different type, and while a work on clouds by Mr. Cave will undoubtedly be read by most meteorologists, the book is not intended for those engaged in the study of the weather but for the general public, and more particularly for artists, whose knowledge of cloud forms is often shown by their works to be very slight. In accordance with this object, the book is written in the simplest manner and contains scarcely any reference to meteorological theory.

The first half of the text deals with the colour of the sky, including sunset colours, with rainbows, halos, and other optical phenomena, describing under what conditions and in which parts of the sky these are seen. The next section is devoted to clouds, the international nomenclature being followed and the types illustrated by twenty-two excellent photographs taken by the author, placed together at the end of the book. Some notes on the position and appearance of the moon at different seasons conclude the volume. Perhaps one may be allowed to express a doubt whether even an authority like Mr. Cave, backed by the Cambridge University Press, will be able to reform the ways of artists, but all meteorologists will extend a hearty welcome to the book and wish the attempt success. J. S. D.

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.*]

Science and Psychical Research.

IN NATURE of July 31, Dr. Tillyard, the well-known entomologist, reproaches Huxley for not being interested in the phenomena of what Sir Arthur Conan Doyle and others call spiritualism. He extends this reproach to all who consider the claim that from "the organism of the medium 'psychic stuff,' by the moulding of which they [the invisible operators] can produce at will the phenomena of independent voice, levitation, materialisations of portions of their personalities, and so on," so highly improbable that they refuse to spend their time and energy in the efforts required for obtaining or refuting proof. Yet it is by such limitations, and by them only, that science has hitherto obtained its results.

No doubt Dr. Tillyard, guided by the experience which he gained during a long and successful career in entomology, would refuse to investigate reputed cases of insects with bony skeletons suckling their young. Why then should he be so hard on the physicist who, on the ground of his experience, refuses to investigate levitation, or on the biologist who, mindful of Harvey's *omne vivum ex ovo*, considers his time better spent in his usual pursuits than in an investigation of reputed "materialisations of portions of personalities"?

Dr. Tillyard evidently approves of the scientific movement which displaced the medieval church from its position as the guardian of all knowledge—natural as well as supernatural. Why then should he object to that great majority of his fellow-scientists who think that the change would be for the worse if they accepted the guardianship of the medium? This, however, is what Dr. Tillyard really advocates; he is not satisfied with the liberty accorded ungrudgingly to any one willing to investigate even the most improbable phenomena; he wants physicists and biologists to leave "the broad highway" of science and to enter "The neglected side-path, foul with mire and overgrown with noxious weeds" along which the medium is anxious to guide them. If science did so help, its name would be superstition.

J. P. LOTSY.

LIKE Mr. Campbell Swinton, Dr. Lotsy confuses psychical research with spiritualism; he then charges me with reproaching Huxley for refusing to be interested in the latter! If he will again read carefully through the third paragraph of my article and follow it logically with the beginning of the fourth, he will see how far he has wandered from my meaning. He then selects the rarest and most puzzling of all psychical phenomena, namely, the ideoplastic moulding of teleplasm into forms resembling "portions of personalities," and says that I extend my reproach to all who refuse to consider this as a valid phenomenon worthy of scientific study! This would be rather like reproaching a peasant who lived in the middle of Asia for refusing to believe in the existence of submarines when he had never even seen the sea!

Dr. Lotsy is quite sure about what I would do if I were confronted with reputed cases of "insects with bony skeletons suckling their young." I am not! If one of our leading entomologists were to write to me and state that he had observed a case of one of the higher pupiparous Diptera suckling its young, I should most certainly want to investigate it, though I might feel sceptical about his use of the term "suckling." The more improbable the reputed facts, the more I should consider the weight to be attached to the reputation of the man who made the statement. If the fact were vouched for by three entomologists of the standing in their own science that Lodge, Crookes, and Richet hold in theirs, I should consider that a good case for investigation had been made out. The weak point of Dr. Lotsy's argument is that he tries to draw a comparison between something in entomology which has never been even 'reputed' to occur and something in another branch of science which many leading men of science state clearly has occurred in their presence under test conditions; so that the only question which remains is to decide whether it is really true or whether they are liars or under delusions.

As for Harvey's *omne vivum ex ovo*, I doubt very much if modern biologists are compelled to regard this as a strictly accurate statement of the origin of life. Certainly Dr. Lotsy himself does not, for he has been trying for years to get them to accept instead his own emendation of *omne vivum ex hybrido*! Personally I prefer Harvey's dictum, but I do not think that the first unit of life that appeared on our world was either an egg or a hybrid. Moreover, the phenomena of teleplasm do not controvert Harvey's statement. For the 'psychic stuff' itself is admittedly drawn from the physical organism of the medium, and the medium is "ex ovo." Even if the ideoplastic moulding is really done, not under the control of the subconscious mind of the medium but by the will of an invisible operator who has once lived in the flesh, that operator by his own claims and admissions was once "ex ovo." The facts of psychical research do not *contradict* any of the broad principles of biology.

Finally, Dr. Lotsy makes the usual blunder of those who, knowing nothing of the elementary principles of psychical research, persist in regarding the medium as the 'guide' in the experiments, whereas the medium is actually in trance and does not know what is going on. I can only repeat that the conditions of the experiments are just exactly what the researchers choose to make them; the facts can be studied and tabulated like other scientific facts. My plea is simply one for assistance instead of obstruction in the attempt to obtain them. To parody Dr. Lotsy's last sentence, "If Science do not so help, then her name is stagnation"

R. J. TILLYARD.

Zürich, Switzerland,
August 26.

MR. CAMPBELL SWINTON'S account in NATURE of August 28 of the incidents connected with the Combermere photograph is both inaccurate and misleading. Since he uses my name so freely perhaps you will permit me to state shortly the true version. The whole story, with the photograph, will be given in the next number of *Psychic Science*—the organ of the Psychic College.

This photograph, which shows plainly the outline of an elderly man seated in an armchair, was sent to me with the endorsement of the Combermere family, who may be expected to know as much about the matter as their relative by marriage. On the back was written that it was taken by a certain lady at the time of the old peer's funeral, and that the shadowy figure was supposed to be the wraith of the

deceased man. This I showed (among fifty other psychic photographs) at the Queen's Hall, simply giving the facts as supplied by the family, and making no assertion myself, since I had no personal knowledge of the matter. Shortly afterwards, several violent letters appeared in the press from Mr. Campbell Swinton, in which he used such injurious terms as "photographic fraud." As to the seated figure, he gave in successive letters three different contradictory explanations; the first that it was a photographic flaw, the second, that the butler had crept into the room and seated himself in the chair; and the third, that plates if kept for some time before development may show strange images. He wound up by challenging me to publish in the *Morning Post* the 'ghost' photograph, alongside of a photograph of the peer taken in life. I at once sent up my photograph without any suggestion whatever that it would not reproduce. That statement is pure invention upon the part of Mr. Campbell Swinton. The editor refused to take the risk of an inferior reproduction, and could only guarantee a good one by touching up, which would be objectionable. A reproduction was afterwards made by the *Daily Sketch*, but whether touched up or not I could not tell.

That is all a technical question with which I had nothing to do. What was, however, strange and rather amusing was that when the photograph of the peer was finally published he proved to be remarkably like the 'ghost,' having a very high forehead and some indication of a short tufted beard. Thus the result of Mr. Swinton's labours was to add one more point to the argument for the authenticity of the picture. There is clear evidence that there was no male visitor or servant in the house who wore a beard.

ARTHUR CONAN DOYLE.

September 1.

[NO useful scientific purpose would be served by the discussion in NATURE of the production of spirit photographs or of the reality and origin of the various phenomena manifested during séances with a medium believed to be in a state of trance and to know nothing of what is occurring. The main point of Dr. Tillyard's article in NATURE of July 31 was that scientific men generally presented an unscientific attitude to the subject of psychical research; and he pleaded for critical inquiry in a field hitherto mostly neglected by scientific investigators. This alone is the matter which we think may be usefully discussed in NATURE, or to which we are inclined to devote space.

In his letter Mr. Campbell Swinton raised the question of the alleged spirit photograph of the second Viscount Combermere, his uncle by marriage, and it is only just that Sir Arthur Conan Doyle should be given an opportunity of replying. We do not propose, however, to let other correspondents range themselves on either side in regard to the authenticity of the Combermere photograph, or to submit or expose evidence of psychic phenomena of any other kind. For the present, at any rate, correspondence must be limited to the plea made by Dr. Tillyard for "the *scientific* study of what are called *supernormal phenomena*."—EDITOR, NATURE.]

The Three-dimensional Reproduction of Tracks of β-particles Ejected by X-rays.

THE use of a stereoscopic camera by C. T. R. Wilson in the photography of tracks of β-particles ejected by pencils of X-rays led to the revelation of two types of asymmetry of initial direction of ejection (*Proc. Roy. Soc.*, A, 104, 1923). One is characterised by an excess of tracks having their initial portions in or near the plane containing the X-ray pencil and its electric vector; the other by an excess of tracks having a forward component in their initial velocities. They have been termed 'lateral' and 'longitudinal' asymmetry respectively. The former distribution reveals the partial polarisation of the primary beam, the preponderance of primary X-rays the electric vector of which is in the plane containing the cathode stream. The latter distribution has been accounted for qualitatively on the basis of Richardson's hypothesis that the absorption of a quantum $h\nu$ of energy by the electron is accompanied by the transference of the momentum of the absorbed radiation causing a resultant motion in the forward direction. A third feature of interest and importance revealed by Wilson's photographs was the existence of short, unidirectional, fish-like tracks with tails towards the X-ray source and produced only by X-rays of wavelength not exceeding about 0·5 Å.U. The phenomena of fish-tracks are most completely and satisfactorily explained by the application of the Compton quantum theory of scattering of X-rays.

In further examination of these features other investigators have adopted the stereoscopic method. F. W. Bubb, in an examination of the initial directions of β-particles ejected by polarised X-rays scattered by a paraffin block, has photographed the tracks directing the camera lens axes end-on to the X-ray pencil for the observation of lateral asymmetry and broadside-on for the observation of longitudinal asymmetry. O. K. de Foe and D. H. Loughridge have examined independently longitudinal asymmetry by stereoscopic photography from the broadside-on position. The latter calculated initial direction of ejection from measurement of depth in the photograph of the end of the initial straight portion by means of a stereocomparator, and of height and breadth by direct measurement by dividers.

The work of F. Kirchner involving the stereoscopic photography of tracks produced by Compton electrons was described by Prof. W. Wien in his paper "On the Direction of Electrons emitted by the Photo-electric and Compton Effects," read before Section A of the British Association on August 10, 1926. Prof. Wien referred to the difficulty of ascertaining correctly, by examination of the photographs stereoscopically, the initial directions of the tracks with reference to the primary X-ray pencil. This difficulty had been met to some extent by the co-option of observers who could not possibly have any 'Compton bias.' I myself experienced this difficulty in some work done in 1924 in which I examined stereoscopically tracks produced by $K\alpha$ copper radiation homogenised by reflection from rock-salt, and was led to consider the possibilities of photography in two directions at right angles eliminating the stereo-vision difficulty and at the same time increasing very considerably the precision with which the forms and initial directions of tracks could be determined, It appeared, too, that such photography would avoid two other difficulties inherent to stereoscopic examination of lateral asymmetry in which photographs are taken end-on to the pencil. Tracks would be formed across the full width of the cloud-chamber (15 cm., say), and it is impossible under the conditions of the experiment for all to be sharply in focus. Also, even in the absence of this difficulty overlapping and confusion is inevitable.

It was at once evident that the most suitable directions of the lens-axes, using separate single lens cameras and the direction of the primary X-ray pencil being horizontal, would be the vertical and horizontal perpendiculars to the pencil. The photographs so obtained would give the projections of

tracks on two perpendicular planes. Measurement of the angles made by the initial straight portions of the projections with the direction of the X-ray pencil makes it possible to calculate the angle between the actual initial portion of the track and the plane containing the pencil and the electric vector (δ) and the angle between that portion and the direction of the X-rays (θ). Statistical examination of values of δ and θ might then be expected to show most probable values of these angles and the existence of lateral and longitudinal asymmetry. Further, it would be possible to determine the three co-ordinates of any point on a track and therefore the true path of the β-particle in its flight through space.

In practice, adopting the Wilson mercury-lamp flash method of illumination and directing the illuminating beam almost horizontally on the line of the X-ray pencil, it was found that whilst ample light was scattered forward, giving good records in the horizontal camera, so little was scattered at right angles, that is, vertically, that the tracks were not recorded on the negative in the vertical camera. This difficulty was overcome by placing in the appropriate position on the base of the cloud chamber a right-angled glass prism and producing total internal reflection of the illuminating beam in a direction bisecting the angle between the axes of the cameras. Photographs so obtained were of satisfactory and approximately equal density.

Measurements have been made by low-power microscopic observation of the negatives directly and the advantages anticipated by the substitution of right-angle for stereo-photography realised. Using heterogeneous X-rays and moist air in the chamber, the existence of both types of asymmetry has been found. Experiments are now in progress in which homogeneous X-rays produce tracks in gases other than air.

ORRELL DARBYSHIRE.

Physics Department, Armstrong College,
Newcastle-upon-Tyne, August 19.

Spatial and Time Relations in Dreams.

IN NATURE of August 7, Dr. J. H. Kenneth refers to my letter which appeared in the issue of March 17, 1923, and he describes further observations of hypnopompic images.

In my letter I referred to an observation at the high-speed extreme end of the scale of time, in which the speed was so high that the image consisted only of blurred fleeting parallel lines, seen in an almost unconscious state. Curiously enough, after more than a year without any observations worth mentioning, I was enabled this very morning to confirm my statement that " the speed of succession (I ought to have said, of translation) of the images is an inverse function of the degree of wakefulness," by an observation at the other extreme end of the scale, thereby completing the series of observations necessary to establish the relation between speed and consciousness on a sound scientific basis.

I had just been roused from a deep sleep (the whole of the previous night having been spent journeying in a railway carriage, and therefore practically sleepless), I had exchanged a few words on the weather with the person who had awakened me, and I was therefore *quite awake*; I had closed my eyes for a few minutes before getting up, when, to my surprise and delight, an image at an *absolute standstill* appeared suddenly. The image represented a grassy rising slope with outcropping rocks, the details being so clear that, had time permitted, I could have counted the rocks; it lasted some eight or ten seconds before vanishing, and during that time it remained quite motionless. While observing its details I was fully realising that I was witnessing the process of unconscious mind-picture forming at the hitherto unobserved zero end of the scale, and verifying the relation I had expressed several years ago, and to which my attention had been again called by reading, last night, Dr. Kenneth's letter.

It is perhaps significant that, two days ago only, I was in North Wales and I had climbed the Moel Siabod (2860 ft.) alone, and therefore with my mind entirely free from diversions, and naturally concentrated on the orographic feature which had faced me during most of the time taken by the ascent, namely, up to the final steepest climb, a grassy slope from which emerged innumerable rocks.

I have used above the word ' mind-picture,' but it must be understood that such a hypnopompic image is quite different from a mind-image, as usually conceived, every detail of which is necessarily the result of an act of volition on the part of the person whose mind forms the image. A hypnopompic image appears as a whole, in all its intricacy of wonderful details, without any volition whatever. In the *Journal of the Society for Psychical Research* I have stated that the image seems capable of gradual modification at the result of volition, but on the whole my observations do not seem conclusive enough on this point, and it remains doubtful.

This study of hypnopompic images is not only very interesting, but it is also perhaps the only direct path of approach towards the elucidation of the *modus operandi* of the formation of an image by the mind and its perception as such, with all its minute details. Occasions in which such images come under reasoning observation are necessarily few and far between, and all students of psychology are greatly indebted to NATURE for keeping on record such scanty observations as are available, and which otherwise would be lost, or fail to fall under the notice, and awake the interest, of others.

The principal features of interest are, besides the speed relation referred to above, the possible simultaneous existence of several superposed ' films,' their variable inclination and the possibility of their snapping, referred to in my letter. Dr. Kenneth has established a most important feature, namely, the relationship between the inclination of the line of motion and the position of the observer, which I have so far failed to notice. I have forgotten the details of the observations described in my letter to which Dr. Kenneth refers, and I must therefore abide by my notes; these seem to imply the simultaneous existence of several films, superposed and at different inclinations, and this is at variance with Dr. Kenneth's observations. As the latter appear to be much more precise than mine, so far as this particular question is concerned, mine consisting but of one single instance, noted in passing, while my mind was concentrated on other details, I think that they should be given more weight, until my own observations are confirmed. Both states can possibly occur, according to circumstances.

M. E. J. GHEURY DE BRAY.

40 Westmount Road,
Eltham, S.E.9, August 22.

Pernicious Grafting.

THE question raised in a letter on this subject from Dr. Grabham in NATURE of July 17 is one of very real interest to horticulturists in Great Britain as well as to growers in Madeira. Examples of ' incompatibility ' between stock and scion occur in practically all the commercial fruits which are propagated

by budding or grafting. Moreover, there is a very complete graded series, ranging from the case in which perfect harmony apparently exists between the two individuals, to that in which they are quite incompatible and no growth at all takes place. It may be, for example, that the dwarfing influence of certain stocks upon scions is the result of incomplete harmony. The phenomenon is more distinct in the case of stocks sometimes used for pears, upon which some varieties will grow perfectly satisfactorily for one or even two years, after which growth ceases and the plant eventually dies. A slightly different aspect of the matter may be observed in the case of plums, in which it is a matter of difficulty to induce the budded scion of some varieties to grow at all on certain stocks, and it should be emphasised that success depends upon both stock and scion. Whilst a variety which does not 'take' well on one stock grows quite satisfactorily on another, at the same time a stock which is unsuitable for one scion proves a good 'mother' to others.

It has been established at this Station that even seedlings which are closely related may vary considerably in their capacity to unite with a scion. The seedling Myrobolan plum stocks of commerce are an example of this variation. One Myrobolan seedling, for example, gives 95 per cent. success with buds of Czar plum, whilst another from the same batch gives less than 50 per cent. of satisfactory unions with the same variety. A similar range of variation exists within single groups of seedling stocks used for peaches; for example, the S. Julien group.

The problem is somewhat complex physiologically, and at present it is not even possible to state it accurately, although observations are now accumulating to this end.

From a practical point of view, there are two possibilities of circumventing the difficulty. Some pear varieties are incompatible with quince stocks, but a satisfactory tree is obtained by the process of 'double grafting' or 'intermediate grafting,' which involves grafting a compatible scion on the stock and regrafting the desired variety on the first scion a year later. There appears to be no reason why this method should not succeed with peaches.

A more certain method of avoiding the effects of incompatibility is to discover a stock which is suitable for the desired variety and to propagate that stock vegetatively. In this way the variation which is involved in the use of seedlings is obviated.

R. C. KNIGHT.
RONALD G. HATTON.

East Malling Research Station,
East Malling, Kent,
August 17.

THE ill effect which often follows the grafting of the peach on seedling stocks described by Dr. Grabham in NATURE, July 17, is very common in peach nurseries on the Western Frontier of India, especially when the peach is budded on the almond. In the summer of 1919, a few weeks before our service in Baluchistan came to an end, we paid some attention to this matter, the results of which are published in the *Indian Forester* of December 1919. We found that the restricted growth which often follows budding was due to imperfect sap circulation caused by an abnormal amount of callus tissue at the point of union between the stock and scion. Analyses of the peach leaves of affected trees in September 1919 showed that they contained less nitrogen, ash, phosphorus, lime, and potash, and much more starch, than normal leaves. Consequently root development was far below the average.

The trouble can be avoided (1) by ring budding the peach either on seedling peach or seedling almond stocks and (2) by destroying all weakly abnormal plants in the nursery before planting out. Ring budding is best done when the peach or almond seedlings are growing vigorously in the early summer. At this time a ring of bark, with one bud, is easily removed from the parent peach tree. This is placed in water and at once fitted on the cylinder of wood of the seedling stock, care being taken to push it well home and in contact all round with the living bark of the stock. Union is rapidly established and the peach bud begins to grow in about ten days.

The adoption of this method of propagation in Madeira, combined with the elimination of all abnormal plants in the nursery stage, would probably solve the difficulties described by Dr. Grabham.

ALBERT HOWARD.
GABRIELLE L. C. HOWARD.

Institute of Plant Industry,
Indore, Central India, August 9.

The Constitution of the Stars.

ON the theory of radiative equilibrium of stellar interiors, as developed mainly by Eddington, the assumption appears to be implicit that the density, mean molecular weight, and other contingent properties of stellar material, vary in a *continuous* manner from the star's surface to its centre. This assumption appears questionable.

Considering for simplicity a star consisting entirely of like atoms, it would appear probable that with the removal of each successive electron from the atom, due to increase of temperature with depth, or at least with the removal of all the electrons constituting each successive quantum-shell, abrupt discontinuities of state would occur comparable, in a general sense, with the separation of atomic matter into its phases.

The recent confirmation by Adams of Eddington's prediction of an abnormally high density for the 'dark' companion of Sirius may be held to prove that an assemblage of 'atoms' entirely 'stripped' of their electrons cannot result from a mere extrapolation of the laws of a perfect gas—or, for that matter, of any phase of atomic matter—to matter in this sub-atomic condition. Eddington's application of his theory of radiative equilibrium to stellar substance obeying the gas laws throughout makes the density at the centre of the star only 'fifty' times the mean density; it seems possible that 'fifty million' would be nearer the truth.

The suggestion is, then, that the central portion of every luminous star consists of 'stripped' atoms and electrons—or possibly in the earlier stages of its life-history at least of protons and electrons—surrounded by successive shells of atoms in various stages of association. As the density, so the pressure and temperature in the sub-atomic core of the star would be enormously higher than on the assumption of continuous variation, and, conjecturally, high enough to condition the building up of the more complex nuclei from the simpler, with the consequent conversion of mass into radiation.

The mean temperature, the effective temperature, and the absolute magnitude of the star would depend mainly on the mass of the central core, and would continually adjust themselves to its variation, so that stability would appear to be assured. But it is easily conceivable that for different stars the total mass may bear very different ratios to that of the central

core, in which case the output of radiation per unit mass of star would correspondingly vary. The view expressed by Russell and Jeans, that differences in this quantity depend on differences in amount of a hypothetical active material, is thus in accord with the hypothesis.

The question of reconciling it—or otherwise—with current views of the course of stellar evolution, is another matter which, if further consideration appears to warrant it, may be dealt with in a future communication. At present I remark only that it suggests an origin for stars in an assemblage of protons and high-speed electrons—the problem of whether and how these have a beginning lies deeper—and an unforced explanation for the occurrence of 'white dwarfs,' differing entirely from either of those proposed by Dr. Jeans or Prof. Eddington.

KERR GRANT.

Department of Physics,
University of Adelaide, July 5.

The Volatility and Dissociation of Borax.

KOLTHOFF (*J. Amer. Chem. Soc.*, 1926, **48**, 1447) states that he has been unable to confirm our statement (*Jour. Chem. Soc.*, 1925, **127**, 150) that fused borax loses sodium oxide. He reports that "even after the substance had been heated for two hours at 800° the weight did not change." His experiments, however, appear to be scarcely precise enough to prove that borax on heating (1) is not volatile, and (2) does not change in composition; as a matter of fact the volatility of borax at high temperatures is well established, having been observed by Hoskyns-Abrahall (*Jour. Chem. Soc.*, 1892, **61**, 650), Leonard (*Chem. News*, 1898, **77**, 104), and Smith and Van Haagen ("The Atomic Weights of Boron and Fluorine," *Carnegie Inst. Washington*, Publication No. **267**, 1918).

We would direct attention especially to the last-mentioned publication, where it is stated that "it is certain and not at all surprising that borax cannot be fused for any considerable time without loss." This evidence is so conclusive as to require no emphasis here. There is, however, another interesting piece of evidence. The inside of the silica muffle used for the fusions of borax in our investigation was completely coated with a white opaque enamel, about 0·06 inch thick, of a product of a reaction between the volatilised material and the silica. Clearly the salt had volatilised in some quantity, and with such a volatile substance, selective loss of the constituents could be detected only by analysing the residues. We believe that the analyses given in our paper can only be interpreted to mean that borax on prolonged fusion leaves a residue poorer in sodium oxide than is required by the formula $Na_2B_4O_7$, and afford definite evidence of a preferential loss of sodium oxide.

H. V. A. BRISCOE.
P. L. ROBINSON.

University of Durham, Armstrong College,
Newcastle-on-Tyne, August 10.

Photographic Theory.

IN the course of photographic investigations at the Royal Observatory, Edinburgh, it has been found by Mr. E. A. Baker that the initial stages of the photographic action, including the deviations from the reciprocity law, are calculable and well represented by assuming that the developable product is formed in two stages, each requiring one quantum; and that the product of the first stage returns in the absence of further stimulus to its original sensitive state, according to the usual law governing the progress of a mono-molecular change. In the case of process plates, where the grains are small and nearly uniform in size, the experimental results agree so closely with those deduced on this theory as to warrant the belief that the departures from it with fast emulsions, where not due to the reversal action, are to be accounted for by the diversity of grain size. The results of these investigations will be submitted to the Royal Society of Edinburgh during the coming session.

Experimental results for single layer fast emulsions and weak light are much to be desired in this connexion. The purpose of the present note is to express the hope that some of the researches at present in progress at different places may be directed to that end, and that results already obtained may be published.

R. A. SAMPSON.

Royal Observatory, Edinburgh,
August 13.

Kaufmann's Experiment and the Spinning Electron.

IN NATURE of August 21 Dr. L. C. Jackson quotes Wentzel as having supposed a *force*

$$(\mu[vX])/c \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

to act on a magnetic electron with moment μ moving with velocity v in electric field X (c is the velocity of light). He deduces from (1) that Kaufmann's experiment shows that the electron cannot have a magnetic moment as large as a Bohr magneton.

Wentzel, however (*Zeitschrift für Physik*, **37**, p. 911), used (1) as *Storüngsfunktion, i.e. energy*. (For an electron describing a periodic orbit in an atom energy

$$(\mu[r'X])/2c \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

would, I think, lead to the correct first order perturbation, but the equations of motion are not of Hamiltonian form and (2) would not apply in general.) Thus Dr. Jackson's argument rests on a mistake. His formula can be seen to be wrong dimensionally. 'He' has not the same dimensions as '$X\mu/c$.' In fact, extra force on a magnetic electron will depend on the gradient of the field. Kaufmann's experiment in no way precludes the electron from having a Bohr magneton of magnetic moment.

L. H. THOMAS.

Trinity College, Cambridge.

Liver Extracts in the Treatment of Malignant Disease.

THE letter from Dr. J. R. Howitt in NATURE of August 21, p. 263, appears to be based upon an extraordinary presumption. The liver, in early fœtal life, is large because it is an active blood-forming organ, but Dr. Howitt seems to suppose that it must have some endocrine function relating to growth. If this idea were correct, it would seem rational to presume that it was a growth-accelerating hormone, for the embryo is growing rapidly. Dr. Howitt seems to think that it is a growth-retarding or, at least, a growth-regulating hormone. That the method advocated may have clinical value is, of course, possible, but it is difficult to understand the theoretical basis of the treatment. I have no knowledge of decreased activity of growth in tumours when associated with enlargement of the liver due either to simple hypertrophy or to resumption of its blood-forming activity.

A. PINEY.

Institute of Pathology,
Charing Cross Hospital,
London, W.C.2, August 22.

Oceanic Isostasy in Relation to Geological Tectonic.[1]

By Sir JOSEPH LARMOR, F.R.S.

1. A CENTURY ago geodetic and gravitational universal surveys were mainly concerned with determining the effective (gravitational) ellipticity of the earth, after due allowance had been made for local anomalies, with especial view to the exact purposes of physical astronomy. One of the chief of these anomalies was exhibited by a remark of Airy, after scrutiny of the available data in his treatise (1830) on figure of the earth in the "Encyclopedia Metropolitana," that the observations show gravity to be abnormally in excess on island stations. It appeared, for example, that this cause might make the mass of the moon uncertain up to 2 per cent. A very refined explanation of this anomaly of island stations (which will be seen presently to be only partially effective) was offered by Sir George Stokes, from whom this last remark is quoted, in the course of a memoir,[2] fundamental for theoretical geodesy, in which he demonstrated that no outside survey could lead to any certain knowledge of the distribution of mass inside the earth, even in its outer crust, except as a matter of probability when backed up by geological knowledge.

It is explained there that the form of the sea-level must be locally depressed over a deep ocean, owing to defect of density; and in consequence on insular stations gravity at sea-level is measured abnormally nearer to the centre of the earth as a whole, so that from this cause its value is greater than that belonging to the mean spheroidal surface. In fact, the form of the ocean is an equipotential surface, including therein the potential of the centrifugal force of rotation in the familiar manner: but the part of the potential arising from the local water is abnormally small on account of its low density, and this defect must, in absence of local compensation, be made up by a greater potential of the earth as a whole, which demands depression of the local ocean surface towards the earth's centre.

The opposite result would arise from excess matter of an adjacent mountain or island peak: that would raise the ocean level in its vicinity and thereby indirectly diminish gravity, measured at sea-level as determined by levelling operations.

For example, at the centre of a circular oceanic basin or radius b and uniform depth h, its defect of potential would be with sufficient accuracy $\int \gamma\rho' h 2\pi r dr/r$, where ρ' is the defect of density of the water below that of the average terrestrial crust; thus it is $2\pi\gamma\rho' bh$, where γ is the constant of gravitation given by $\gamma E/a^2 = g$. Here $E = \frac{4}{3}\pi a^3\rho$, ρ being $\frac{11}{2}$, is the mass of the earth of radius a. As the potential of the earth as a whole is $V = \gamma E/r$, this change of local potential, say δV_0, would be compensated by change of sea-level δh, where $\delta V_0/V = -\delta h/r$. Thus in the present case the fall of level relative to depth of ocean is given by the expression

$$-\frac{\delta h}{h} = \frac{a 2\pi\rho' b}{E/a} = \frac{3}{2}\frac{\rho'}{\rho}\frac{b}{a} = \frac{9}{22}\frac{b}{a},$$

while

$$\frac{\delta g}{g} = -2\frac{\delta h}{a}.$$

If the radius b of the oceanic basin is 50 miles this fall would be the fraction $\frac{9}{22}\cdot\frac{50}{4000}$ or $\frac{1}{200}$ of its depth; if the radius were larger it would increase in direct proportion until it is a considerable fraction of the earth's radius. A cup-shaped ocean could be similarly treated.

The steady sea-level would thus be depressed by $\frac{1}{10}$ of a mile owing to local causes, at the centre of a basin of 500 miles radius and 2 miles deep, in free communication with the other oceanic waters: and this approach to the earth's centre would involve increase of g measured at ocean level, given by $\delta g/g = -2\delta h/a$, or here $\delta g = 0{\cdot}05$ cm./sec.^{2}, where g is about 981, which is over one-third of the order of magnitude of the observed excesses at island stations.

But this explanation fails because there is a predominant offset. The vertical attraction of the local ocean regarded as an extensive flat slab of water is abnormally small by $2\pi\gamma\rho' h$, where $g = \gamma E/a^2$, that is by $g\rho' 2\pi a^2 h/E$ or $\frac{3}{2}\frac{\rho'}{\rho}\frac{h}{a}g$; thus this direct defect in g may be much the greater, being $\frac{1}{2}a/b$ times the indirect excess. There is however some effect in the other direction due to excess density of the local land, which is usually a substantial correction. This preponderance destroys and even reverses the Stokes explanation of the oceanic anomaly. Indeed closer examination shows that, as based by him,[3] rather confusedly as it seems, it depends on a potential equation used by Laplace which can, in limited manner, apply only to a locally infinitely thin spherical layer. The principle of depressed level became familiar, simple examples being worked out, *ab initio* and so correctly, by way of illustration in Chap. IV. of Col. A. R. Clarke's standard treatise on geodesy (1880), from the point of view however only of levelling operations, not of gravity.

But soon the discussion of the data of the Indian geodetic survey, by Archdeacon Pratt in India, revealed new features,[4] by showing strong residual defect of gravity on the Himalayas, such as could only be accounted for by a large defect of density underneath the mountains. Airy's idea that the mountains might be buoyed up by extensive roots floating in a denser magma, existing beneath a *thin* crust, could not of course now be maintained, at any rate in that form, in view of the high rigidity of the earth as a whole. But there was much to be said, on various counts, for a thinner and deeper viscid stratum, lying between the crustal material and the solid core, in which in the tendency towards equilibrium the pressure due to the weight of the crust must in course of ages have become

[1] Abstracted, with Sections 2 and 3 added, from *Proceedings of the Cambridge Philosophical Society*, Feb. 8, 1926.

[2] *Cambridge Transactions* (1849): reprinted in "Math. and Phys. Papers," vol. ii. Some idea of the great debt owed by the Indian and other gravitational surveys to the continuous amateur advice of Sir G. G. Stokes, spread over half a century of their development, may be gleaned from the collection of his "Scientific Correspondence" (Camb. Univ. Press), vol. ii. pp. 253-325.

[3] "Math. and Phys. Papers," vol. ii. p. 153. Stokes did not make any correction in this reprint in 1883; but Dr. Bowie states (*loc. cit. infra*) that there is no generally accepted explanation other than compensating excess of density beneath the ocean.

This analysis of Stokes in fact establishes as a general proposition that the effect of *distant* irregularities of surface mass consists of a direct vertical attraction, say g'', together with an indirect part due to change of level, equal to $-4g''$, thus countervailing four times: this influence, of wide range and presumably actually small, is superposed on the *local* effect here considered.

[4] In 1855–59: cf. A. R. Clarke, "Geodesy," pp. 96-98.

equalised laterally, at any rate partially, and the load upon it thus made uniform to that degree everywhere. It is implied that there are no local abnormalities of density in the core, which is reasonable as the core is probably metallic. This is the hypothesis of isostasy, propounded as a universal principle by Dutton and worked out systematically by Hayford and his colleagues of the American Survey, who found that it gave a fair account of the usually slighter anomalies (mainly of levelling) revealed in that great undertaking.[5]

Circumspection is, however, suggested in applying these ideas to the anomalies at oceanic stations; for the Stokes explanation already claimed to be an effective *vera causa*, without aid from compensation of density underneath. It happens that the subject is amenable in a general way to simple elucidation: and as the essential circumstances for submarine mountains and landscapes can perhaps be more directly estimated, it seems indeed to provide in some respects a closer test. On an ideal very narrow island-peak of negligible mass, in a wide ocean of uniform depth, with adjustment as a whole to general isostasy by denser horizontal strata underneath, there would be but slight resultant abnormality of the local part of the attraction. For the totality of the strata could almost be regarded as an extensive thin flat sheet, while local defect of potential on which change of sea-level depends would be still more closely compensated by the extra mass below.[6] Hence, in contrast to the Stokes uncompensated case above, under isostatic conditions gravity and level ought both to be regular over a wide ocean of nearly uniform depth with strata nearly horizontal underneath.

2. The distribution of gravity over an oceanic surface, beneath which local compensations of terrestrial density are taken to be complete, may thus be envisaged, perhaps most simply, by drawing a widely extended arbitrary horizontal boundary beneath the water, and marking out all above it up to the level surface as ocean separately compensated beneath, the law of depth of the compensation being for that hypothetical layer of the density of water unimportant. There will then remain the effect of the surplus of density, over the oceanic water, of the solid parts situated above this arbitrary flat boundary; and it is from this reduced submarine mountain-landscape alone, together with emergent peaks with density undiminished, and the nature of its compensation, that the amount of the actual local excess of gravity is to be estimated on the hypothesis of isostasy, the circumstances thus being analogous to those of a range like the Himalayas, but modified, as all the observations now belong to the same level near the tops of the submarine mountains instead of the bases. The nature of the compensation, in the deep-seated material, of this effective local excess load, would thus permit of being judged by itself; in particular, for steep submarine island peaks it is almost negligible, whatever varying distribution in depth be assigned to it, provided only it extends deep down, say towards the order of 10^2 kilometres.

The long-recognised excess of gravity at island stations was thus really evidence quite as forcible, and also as direct, as the subsequent records of Himalayan surveys, indicating that the defect of density of the masses of water is actually compensated, even over wide uniform oceans, at any rate to a very considerable degree, by excess of density below.[7] The systematic discussion of the level and gravity surveys of America, primarily by Hayford, has enlarged and forced into prominence the same very striking and surely fundamental type of conclusion, as extended even to the usually smaller and less abrupt anomalies there revealed.

The evidence, then, is on all sides remarkably strong, that with increase of depth the terrestrial material gradually becomes softer, so to say, possibly owing mainly to rise of temperature, down to a limit which perhaps at an outside estimate may approach 10^2 kilometres: that below some such depth the mass of the earth presents again a perfectly solid, though doubtless elastically deformable, foundation on which the softer strata directly above have flowed gradually in the course of ages towards an equilibrium nearly hydrostatic, depending in detail, however, on the distribution and range in depth of the softness, in a way that is scarcely much amenable to scrutiny. To effect such adaptation, the displacement of deep-seated material need be only over slight distances, unless the yielding layer is thin. An unyielding foundation underneath is essential to any approach to local isostasy; the earth as a whole must be solid, as it is known to be for dynamical reasons. As regards the relatively shallow upper terrestrial layer which thus becomes viscous with depth, in a way not necessarily uniform nor to the same depth everywhere, the question of rupture or damping of transmission of internal earthquake tremors in crossing these softer layers arises, and is probably ripe for discussion; such a stratum may of course be even completely yielding for slow secular stress while thoroughly elastic for the rapid alternations in seismic oscillations. It is to be remarked, however, that as a result of theory superficial travelling waves, at any rate on uniform elastic material, could scarcely arise from other than a superficial cataclysm, secondary it may be, so that purely superficial seismic undulations would have to come from sources located within their own quite small range of depth. But the velocity would change (dispersively) with wave-length, and this conclusion may be modified, as Prof. Love pointed out, if the elastic quality or density, instead of being uniform, changes notably within the depth of a wave-length.

Why distinct settlement of the strata towards isostasy such as is thus variously confirmed should be necessary at all, affords direct scope for fundamental tectonic speculation, of an interest quite apart from geological detail. Is this abnormally small density beneath mountain ranges due to higher temperature or to lighter material? How could such locally varying temperatures have become established over a consolidating earth? If the height of the mountains is determined largely by the defect of density beneath, they must to that degree have been pushed up hydrostatically from below rather than elevated by lateral stresses; yet folding of the mountain strata is con-

[5] Cf. the chapter in H. Jeffreys' recent treatise "The Earth."

[6] In the case illustrated above, with radius of ocean about 500 miles and depth of compensation 100 miles, about 10 per cent. of the anomaly both of attraction and of potential would remain after compensation of the ocean.

[7] For recent special estimates see a note by W. Bowie, *Proc. Washington Acad.*, Dec. 1925.

spicuous. Subsidence towards isostasy might perhaps induce folding to some degree. If the depression of the Pacific Ocean is thus determined in the main hydrostatically, is there not less room for the cosmic theory that it may represent the cavity from which the moon was originally shed away?

3. *Postscript.*—One observes that these and cognate questions, insistent and fascinating, form the subject-matter of Prof. Joly's recent path-breaking book, "The Surface History of the Earth," which invokes steady evolution of heat by radioactivity of the rocks, interacting with isostatic influences, as the cause of periodic outbursts of surface activity which have fashioned the existing features. There are to be compared the views developed in H. Jeffreys' recent comprehensive treatise, "The Earth." For a condensed account over an extensive range *cf.* "A Symposium on Earthquakes," by F. A. Tondorf, N. M. Heck, W. Bowie, A. L. Day in *Journal Washington Academy*, May 4, 1926, pp. 233-254 (also more recently G. R. Putnam). In a less special way, such questions have been prominent since the treatise of E. Suess on the earth's surface features. There is also the problem of the time-scale of development, projecting into vast æons of the past, yet with clues arising mainly from the fossil traces of the succession of forms of life.

A few special remarks may be significant here.

It appears that the lag in compensation of accumulating great depths of sediment is but small, compared at any rate with the time of accumulation, for the compensation is always well advanced.

Tidal pulls on these adjustable surface-sheets would on Newtonian principles be differential, and so extremely slight. Thus even the extreme case of an elastic earth surrounded by an ocean of molten lava of the order of 10^2 kilometres in depth, in which continents would be analogous to ice-sheets and mountains to icebergs, is not unthinkable dynamically, however it be thermally; though the existence of the actual oceanic tides would demand a rigid and deep crustal layer.

But even if the lagging tidal pull were large enough, it could only cause a westward drift of the fluid surface material around the earth as a whole, not of continents and mountain ranges floating thereon. For the principle of Archimedes asserts itself; as regards the uniform field of force the floating mass can be replaced by the magma which it displaces, up to the level surface; thus it is the same as if the tidal forces acted on a uniform sheet of magma without surface excrescences and no differential drift could arise—except in so far as a uniform drift may be obstructed or deflected locally by the more solid roots of the floating continents that are carried along with it.

The earliest table-lands, of primitive rock, must have been pushed or floated up, and to great heights; it would appear from the literature that their subsequent denudation by aereal influences accumulated stratified deposits along the coasts of the oceanic hollows, which gradually sank into the magma by their own extra weights, perhaps most in the middle so as to curl over by the lateral pressure,—themselves sinking down while the adjacent denuded high land is floated up, until by accumulation combined with sinking, and helped by effusions from below, they attained to considerable slopes and great thicknesses, even five miles or more, that then somehow they were pushed up again bodily, yielding after repetitions of such processes folded mountain-ranges of stratified rock such as geologists know, the primitive elevations having passed largely out of sight. At any rate nothing more plausible seems to have been hitherto thought of.

The Golden Eagle.

By SETON GORDON.

"Thrice the age of a dog the age of a horse,
Thrice the age of a horse the age of a man,
Thrice the age of a man the age of a stag,
Thrice the age of a stag the age of an eagle,
Thrice the age of an eagle the age of an oak tree."
—*Old Gaelic saying.*

THE golden eagle is the most magnificent bird of the Scottish highlands. Up to the middle of last century, the erne or white tailed eagle shared the cliffs of the western seaboard and islands with the golden eagle, but the erne is now extinct, although so late as the middle of the last century almost every headland of the Isle of Skye had a pair of these fine birds nesting upon it.

The flight of the golden eagle has inspired many poets, and from the earliest times it has been looked upon as lord of the air. In the Book of Proverbs we read:

"The way of an eagle in the air,
The way of a serpent upon a rock,
The way of a ship in the midst of the sea,
The way of a man with a maid."

These, says the writer, are the four things too difficult to understand. Keats wrote in 1818 "Eagles may seem to sleep wing-wide upon the air," and how descriptive are Wordsworth's lines "Faint sound of eagle melting into blue." Scott writes that the eagle from her rocky perch on Ben Venue "spreads her dark sails to the wind."

The eagle is the royal bird of Greek mythology; an eagle of gold was the standard of the Romans. At least three countries have the eagle as their emblem: Assyria, Persia, and Rome. It is, or was, the national arms of France, Germany, Russia, Italy, Austria, and Poland.

At the present day the golden eagle is confined to the central and western highlands of Scotland. In the more accessible districts it is terribly harried by egg collectors, and here very few eyries escape. It is unfortunate that the golden eagle, almost alone among Scottish birds, should never lay a second time in a season, even if its first clutch of eggs be taken when quite fresh, but, despite the egg collector's zeal and the keeper's gun, I do not think the eagle is on the decrease, except here and there. Each pair of eagles has two, sometimes three, eyries. The same eyrie is seldom used two years in succession, because the eaglets remain long (about eleven weeks) in the nest and from

the accumulated remains of prey the eyrie becomes foul towards the end of the time and needs more than a twelvemonth to be thoroughly cleansed by winter frost and summer sun. Some of the Scottish eyries have been used regularly for at least half a century, and probably much longer.

The nesting site may be a tree or a rock. In the central highlands a tree is frequently chosen, and I have seen nests in a Scots fir, and, rarely, in a birch. In her choice of nesting material the golden eagle is most particular. The eyrie may be from six to eight feet in diameter, and the crown on the nest is composed entirely of green fir branches (if there are any fir trees in the district), which the eagle breaks off the trees with her powerful bill. Near one eyrie that I know of a solitary fir grows, and each spring the eagles fly to it and strip it of some of its branches. The lining of an eyrie is, when possible, always made of the great woodrush, *Luzula sylvatica*.

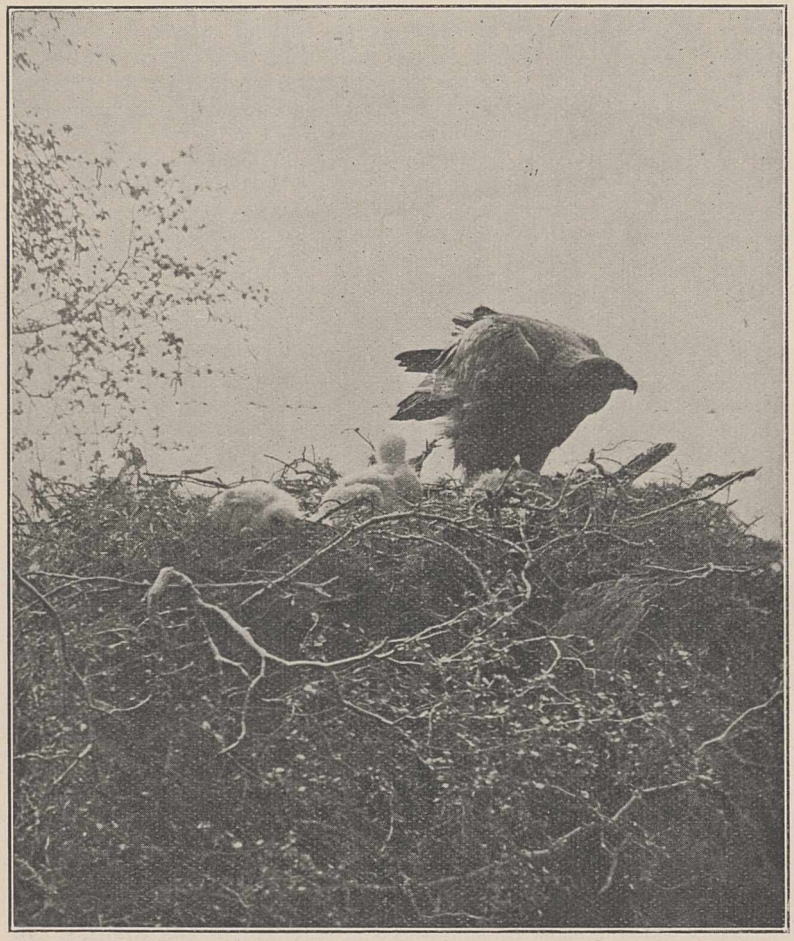

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FIG. 1.—The hen golden eagle preparing to feed the family.

Eagles build early, and I have seen a large branch being carried to the nest on January 27. In the more sheltered nesting-places the eggs are laid in mid-March, and the eaglets hatch between April 29 and May 1.

It is not known whether the cock bird takes his turn at hatching the eggs. In April of the present year I was watching an eyrie when the male bird flew up the corrie and settled on a branch a few yards from where his mate was brooding her eggs. I hoped that I might witness the 'change over,' but, after apparently satisfying himself that all was well, the cock shook himself like a dog (there had been a heavy hail shower a few minutes before), spread his great wings, and was gone from my sight.

Although the golden eagle usually lays two eggs, she frequently rears only one bird, and there is no doubt that one eaglet sometimes kills the other. Last season my wife and I built a hiding tent thirty feet from an eagle's eyrie, and spent between two and three hundred hours in it photographing and observing the home life of the birds. As usual, one eaglet was a hen, the other a cock. In birds of prey the female is the larger, and when the eaglets were ten days old there was a marked difference in size between the two. During the early days of their lives the young hen frequently drove her brother round and round the eyrie. The attack was always entirely unprovoked. Sometimes when the cock eaglet was lying asleep in the nest his sister rose and walking unsteadily over to him aimed a deliberate and vicious blow at him. Fortunately for him the young cock was the quicker of the two on his feet, and I am convinced that on more than one occasion his superior speed alone saved his life. Each time his sister pecked him she tore out much of his down, until the eyrie and the heather around were strewn with this white down. The victim never once retaliated; indeed he was a miserable young person at this stage.

Sometimes, after almost exhausting herself by her attacks on her unfortunate brother, the aggressor stood up unsteadily in the eyrie and flapped her downy wings (her feathers had not as yet commenced to grow), uttering as she did so a wild yell of defiance. It was a weird and very extraordinary cry, and I shall never forget it. Once the mother eagle returned in the midst of this bullying and calmly watched the down being torn from her unfortunate son. Perhaps she thought it better that he should be brought up in a Spartan school.

This pair of golden eagles brought to the eyrie a varied collection of prey for the youngsters. Blue hares, grouse, and ptarmigan were brought regularly, and, more astonishing, the birds hunted squirrels and brought them to the nest. Although the eyrie was in a deer forest no red deer calves were brought, but two roe deer calves were carried up to the eyrie from the low ground. My wife had the good fortune to

be in the 'hide' when one of the calves was brought. The calf was minus head and entrails, and even then its weight was such that the cock eagle had to rest several times upon trees on his way to the nest. He

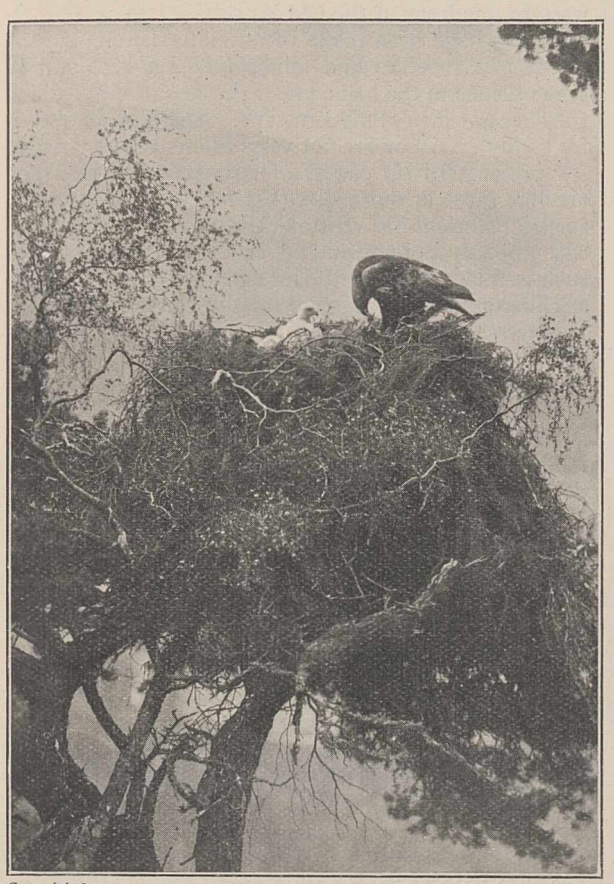

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FIG. 2.—Cock golden eagle tearing up a hare for the eaglet.

was carrying the calf in one claw, and when he arrived he threw down his burden and stood breathless at the edge of the nest. The eaglets were filled with excitement, and the young hen pounced upon the calf with the same weird yells of triumph she had uttered after her fierce attacks upon her brother. The latter picked up a feather from the floor of the eyrie and dashed about holding it in his mouth!

The cock eagle was a magnificent bird. He was smaller than the hen, and his plumage was lighter than hers. He was dashing and debonair; the gleam of his eye was magnificent, and he was a true king of the hills.

One sunny afternoon the interior of the 'hide' was so stuffy that I put my head half out of the entrance to get a breath of air. Against the blue of the sky I saw a small black object which I thought at first glance was an insect. But with incredible speed the dark speck grew in size until I saw that it was the cock eagle rushing down towards the eyrie from the high snow-streaked corries above. He was travelling like a thunderbolt. In one claw he held a ptarmigan, and this extra weight no doubt increased his speed. I suspect that I shall be accused of exaggeration when I say that his speed was at least two hundred miles an hour, but I am convinced that this is no over-statement. I have seen nothing in the bird world to equal that splendid downward rush, and to see it was worth many hours of patient watching.

Regularly about three o'clock each afternoon the cock eagle arrived at the eyrie from his hunting. In the eyrie he laid his prey, and, after looking at his yelping brood for the space of about a minute with indifference, he spread his great wings and sprang into space. On these occasions his mate must have been watching him from a neighbouring tree, for almost immediately he had left she glided down to the nest and fed the family on the prey he had brought.

When the eaglets were small there were days of wild west wind, when the squalls of hail pattered like small shot against the sides of the 'hide.' The eagle's tree rocked in the wind, and the mother eagle, as she guarded her young after having fed them, swayed gently to and fro, balancing herself with all the skill of a sailor when his ship is meeting heavy weather. The young hen eagle left the nest early in July, but the cock, being more backward (partly, no doubt, because of his ill-usage in his early days), was not ready to follow her. For some days the parents fed him in the eyrie, but then seemed to decide that he was ready to leave. Each day they brought him less food, and at last the eyrie was bare. The parents were starving him, and daily he became weaker and constantly

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FIG. 3.—The cock golden eagle brings in a rabbit.

scanned the skies for his father or mother. He practised wing exercises repeatedly during these days, and also practised 'grabbing' exercises with great ferocity. At last, on July 16, the eyrie was vacant—starvation had compelled him to take his first flight, the biggest step in his young life.

The Regional Balance of Racial Evolution.[1]

By Prof. H. J. FLEURE.

THE Oxford meeting of the British Association naturally recalls to one's mind the famous controversy about evolution, the fact of which is now universally accepted despite little outbursts where old modes of thought survive on the fringes of civilisation. The application of the idea of evolution to the study of mankind has been carried very far, and we have especially Elliot Smith's recent summary with its emphasis on correlated improvements of eyes, brain, and hands. I shall not venture upon the ground so well covered by one of our greatest leaders, but shall merely add a few points necessary for my main purpose, which is an attempt to outline the field of research into the distribution of the characteristics of modern living men.

First may be mentioned the very probable, not to say certain, lengthening of pre-natal life from about 220 to 280 days, with consequent continuance of growth of brain and delay of hardening of frontal and facial elements and the passing of the stage at which hair was previously developed now under new conditions conducive to the maintenance of embryonic, downy hair (lanugo), rather than to the growth of the definitive hair. Thus the lengthening of pre-natal life seems to have been an important factor in that reduction of hairiness which is a feature of mankind. It has also contributed to the increase of skull volume and of consequent difficulty in head support, so that infancy and opportunities for lengthened maternal care have been prolonged. The postponement of fixation of characters, the maintenance of more or less embryonic conditions with resulting unfolding of new features in response to opening up of new possibilities, has thus become a cardinal fact for the human race.

The prolongation of infancy has also contributed to differentiate women's work from men's work, and it may well have accompanied the growth of the hunting habit in man; woman remained more a gatherer. This differentiation increased personal relations and gave two mutually supplementary types of food, doubtless a valuable step forward at that stage of evolution. The consequent enrichment of social life is an obvious fact, but in mentioning this one must emphasise that human society does not so much result from the coming together of individuals as that human individuality results from the liberation, bit by bit, of individual initiative within groups.

The stone implements of early Pleistocene man are generally of a few types only, though they may be wonderfully executed. The heavy hand of tradition has often limited initiative, but also often allowed the compensation of the craftsman's joy. Mid-Pleistocene man, at least, seems to have made ceremonial burials and thus, perhaps, to have begun to dream of a future life. It is with the Aurignacian phase, or the beginning of the late Pleistocene, or, to use another name, the beginning of the neanthropic period, that we note a great liberation of initiative, and it is from this phase that we have the earliest assured evidence of modern types of man, so far all or almost all from the north-western quadrant of the Old World.

Efforts have been made to estimate the climates at which men's bodies and minds function best and to argue thence to the home under the conditions of which they became men of modern type. The best conditions for bodily efficiency are not very different from those of our present British climate, for mental efficiency they are like those of our cooler (but not too bitterly cold) spells. Olbricht has ventured the suggestion that there was probably a big mental advance during a cold period such as a late phase of the ice age; but at such a time a climate like our present one favoured the south Mediterranean and the belt from the Sahara to Mesopotamia, perhaps only this belt. This belt seems to give abundant evidence of inhabitants of, possibly, mid-Pleistocene date.

We may venture provisionally to place the early modern men in the zone from the Atlantic edge of the Sahara to Persia, and should think of a fairly large population not all exactly alike. What sorts of men were they?

They may have been more or less brown-skinned with blackish hair and brown eyes, with jaws and brow ridges much reduced from the conditions known in many of the earlier forms of man, with heads almost balancing on the vertebral column, but the erect posture not yet attained in all cases.

The well-known youth and old woman from the lower layers at the Grotte des Enfants, currently known as the Grimaldi type, were short, with broad noses and strongly projecting mouths, but without brow ridges. Their heads were long, narrow, and high. They have often been said to be negroid, but it would be wiser to say that both in them and in many living Africans we find some of the same characters.

The name of Cro Magnon has often been used as a label for nearly all the types of the late Palæolithic except the Grimaldi skeletons just mentioned. Giuffrida Ruggeri urged a more restricted use of the term, but his views were held back from general acceptance for a while owing to exaggerations due to Klaatsch, exaggerations which Klaatsch retracted before he died. Using the term more carefully and more strictly, it applies fully to about four skeletons and partially to two or more of presumed Aurignacian date as well as to other later ones. In the Cro Magnon type the head is long absolutely, but only moderately long relatively, the cephalic index being about 74, 75, or 76. The height of the skull is much less than its breadth, the nose and chin are strong and narrow, the brow ridges do not stand out separately in front of the forehead, the stature is great, the cheek bones are large and project laterally, and the face is short and broad.

It is difficult to accept either the Brünn or the Brüx calotte as suitable objects from which to name a race, and there are difficulties about naming it from the Combe Capelle skull. We await anxiously the full description of skulls found at Predmost. The general characters here are extreme length and narrowness of the head, so that the cranial index is rarely so high as

[1] From the presidential address to Section H (Anthropology) of the British Association, delivered at Oxford on August 9.

73 on the skull; the height of the skull is usually greater than the breadth, the brow ridges are well marked and in this connexion the rather exaggerated term 'Neanderthaloid' has often been used. There are a few skulls otherwise belonging to this type which are low in the vault.

Skulls from Solutré show high heads without strong brow ridges, but heads which are so much shorter as to make the usual index 78-83. We await confirmation of the date and detailed descriptions of the Solutré skulls.

Reviewing these early skulls comparatively, we notice that great length of head is a very general feature. This is combined with a very narrow and rather high-ridged form in some cases, and a less narrow and less high-ridged form in some others.

The great majority of the apes and the extinct types of man do not seem to have been relatively long-headed, if we are careful not to include the enormous brow ridges of some of them in measuring the head length. Comparing the skulls of Aurignacian men with these others, we note a marked growth in length, especially in front of the ear. This implies special additions along the coronal suture. Now the temporal muscles were of very great importance to the flesh hunters of the late Palæolithic age, who doubtless had to tug at flesh food. They had been important, no doubt, in earlier times as well, so they may be looked upon as an ancient feature persisting for a while and exerting an influence on the new growth. The early closing of the sagittal suture gave a firm anchorage to the temporal muscles and limited growth in breadth anteriorly at least; increase of anterior space must thus be secured mainly by increase in length. It is therefore permissible to suppose that a great lengthening, extreme in some cases, was a feature of skull growth among most, but not necessarily among all, early representatives of modern types of man.

In several cases the two sides of the skull roof seem to have been pulled down, or in other words the sagittal line was ridged up, and this is found frequently associated with a deep temporal hollow, so that the brow ridges are left outstanding. In other cases the temporal muscles seem to have pulled the sides down to a lesser extent, and the head is less narrow and the brow ridges less outstanding. Lest too much importance be attached to the pull of the temporal muscles, it is well to remember that the face was still heavily developed in most early examples of modern man, and that to balance this the head tended to grow so as to project backwards, *i.e.* to grow in length.

It is thus possible to think that in the evolution of modern men we may have:

(*a*) Types with little of the additional growth just mentioned. These would be sub-brachycephalic and small.

(*b*) Types with considerable growth, almost entirely growth in length, and with the sides of the skull sloping steeply from the sagittal ridge. These would be hyperdolichocephalic and usually high-headed, often with strong brow ridges.

(*c*) Types with considerable growth in length but without the sharp down slope of the sides. These would be more moderately dolichocephalic than (*b*), less high-headed and usually with less strong brow ridges.

(*d*) Types with considerable growth more generally distributed along the various sutures. These would be mesaticephalic or sub-brachycephalic with parietal rather than frontal breadth as a distinguishing feature.

I think it useful to figure the great lengthening as a feature in the main groups of early modern men in the early home zone, and then to think that there were fringing groups who remained without this lengthening. These fringing groups on the hot south side, probably subject to unfavourable conditions, would have relatively small growth and would remain as small mesaticephals. On the cooler north side they, then or later, were able to accomplish longer continued growth and so gave better grown, larger headed mesati- and sub-brachycephals.

The first group seems illustrated by the Andamanese, Semang, Aeta, Tapiro and other pigmies of south-eastern Asia, and the Akka and other small peoples of equatorial Africa, the last being much less strongly pigmented than the others. All have flat, broad noses, the Tapiro less than the others. It seems almost necessary to think that some of these types have left their mark on the population of various parts of India, and some of their characters seem to survive also among various African peoples other than the equatorial pigmies. The Bushmen, on the view here sketched out, would be types showing some measure of head lengthening, and the Tasmanians also.

I have not mentioned hair. The downy hair has fairly straight roots even in Bushmen, and the spirally curved hairs so characteristic for Africa develop that curve with a sharp angle between it and the root. As ape hair also has fairly straight roots, it thus seems likely that spirally curved hair is a specialisation among some early types of modern man, chiefly, I think, types on the south side of the early home zone under hot conditions, where hair reduction and the pressing of the roots up toward the surface would allow the freer giving off of heat.

Next we may think of cases in which head lengthening had taken place fully. Broom's Hottentots and Koranas fall here, and so do most of the African peoples. Among some the pressing of the hair roots up to the surface has made possible a large growth of blood vessels in the skin, and the reduction of hair has gone very far in certain cases. The thin supple epidermis without many dry non-conducting layers, the everted lips, as well as the development of skin blood vessels and the reduction of hair, all promote cooling.

It was mainly types with broad, flat noses, prominent mouths, feeble brow ridges, and spirally curved hair that drifted southwards in Africa, from the south flank of the early home zone, but a brow-ridged type also went that way.

The south-eastward drift was a drift rather from the end than from the flank of the early home zone, and for this reason it was more varied. Pigmies with spiral hair and medium broad heads; dark Tasmanians with spiral hair and partly lengthened heads; south-east Australians with lengthened but often low heads, dark colour, and wavy hair; North Australians with lengthened and high heads, dark colour and wavy hair; Papuans and Melanesians with long high heads, dark colour, and spirally curved hair and so on—an interesting series of drifts through a long and relatively narrow

belt. This contrasts with the African drift through a wide belt lying on the south flank of the early home.

Let us turn now to the northern flank of the early home zone and think of migrants across from Tunisia to Sicily and Italy, migrants mostly with very long heads, the bearers of Capsian culture to Europe. In addition to these we have to think of people drifting northward between Elburz and Hindu Kush as the ice diminished. Once north of this barrier the human drifts could spread either north-eastwards in the lowlands or north-westward to the European loess. These early drifts have been pressed upon by subsequent streams and their survivors are now found in peripheral situations and in a few refuges on the way. Survivals of these early characters are shown in types found at Plynlymon. The new work on blood constituents is interesting in that it is tending to show that the blood of the peripheral, longheaded peoples is inherited with little alteration from a phase before certain specialisations occurred in the composition of the blood of many human stocks.

When the belt of the westerly winds from the Atlantic shifted northward as the ice sheets diminished and the land sank in north-west Europe, inner Asia lost its rain to a large extent, but melting ice seems to have kept it moist for some millennia. Mesopotamia remained moist for the same reason for a good while. The change of climate in north-west Europe produced a human crisis; the spread of the forest broke the old schemes of life, especially as the first phase was that of a pine forest, very unfriendly therefore to man. In south-west Asia, wild barley and possibly wild relatives of wheat have been found. Somewhere then, probably on the northern fringe of the early home zone, there arose sooner or later a culture complex, including cultivation of wheat and barley, the art of stone grinding perhaps developed through the use of stone for digging, the consequent invention of the stone wedge, and so the rise of new power over wood to haft tools, to make palisades that kept animals under man's command for milk, etc., the making of pots, the dawn of metallurgy and so on. I think of this complex, provisionally, as spreading among hill folk rather than plains-men, for the latter might more easily keep up their old habits of following herds of animals, and it seems that it spread through Anatolia to Hungary and so, after a long history, ultimately to western Europe probably about the end of the fourth millennium B.C. There is, however, no need to picture the awakening west as copying exactly from old and distant cultures.

The mastery of a wood technique, food production, and the potter's art all helped home-making and the provision of soft food for infants, delaying the hardening of the skull or, in other words, prolonging infancy. In this connexion one pictures diminution of jaws and brow ridges and freer growth of the skull along many sutures leading to a maintenance of the mesati- and sub-brachycephalic skull form. This form and the brachycephalic form, which I believe is derived from it, are mainly characteristic of the great mountain belt of the Old World.

Another factor that enters into the story here is the probable increase of chewing at the expense of tugging, and Prof. Thomson and others have associated with this an increased width of the malar bones to which the masseter muscles are largely attached. Increased width of face and jaws is likely to have encouraged increased width of head as well. It is important to note that there has been no suggestion that some functional change in the jaws led to a transformation of dolichocephaly into brachycephaly. The suggestion is rather that the brachycephals have originated from fringing mesaticephals or sub-brachycephals. I appreciate and accept Prof. Thomson's observations and views on the lower jaws of the typical broadheads. These thoughts make me incline to criticise our present use of terms for skull forms.

Brachycephals give one the impression of evolution and drift from Anatolia and surrounding regions. It is noteworthy that Pamir broadheads are much like Alpo-Carpathian and Cevenole. For the present, I look upon the extreme broadheads of the high plateaux of east central Asia as showing in some cases a flattening of the nasal bones and an insinking of the nasal chambers, but others have the profile prominent enough. The broadheads of the high plateaux have yellow-brown skin, the early brown being retained and the yellowness being increased by the insinking of blood vessels, and the thickening of the dry superficial layers—both protective devices in a region of intense winter cold. The very variable extra fold of the upper eyelid may have begun as a consequence of the facial flattening, and once developed would be a valuable protection against glare.

The well-known diagram of Ripley shows the distribution of broadheads in Europe as known in his day, and its relation to the mountain zone is very marked. A preliminary attempt has also been made to design a map of types in Europe. Around the mountain zone the broadheads have spread and the longheads are mostly peripheral in the north-west and in the south-west. In the north-west, climate encouraged long continuation of growth and diminution of pigment, and I look upon the tall fair Nordic as to a large extent a regional specialisation. In the south-west the Mediterranean type links on to the Hamitic type of North Africa and the longheads of the Arabian wastes, all having among them an element surviving with little change from the early days of modern man, but many showing somewhat more general growth along the various sutures, and therefore less extreme length of heads. The fundamental element of the British population I look upon as drifting from the continent in late Palæolithic times, with a southern element fairly well represented but, nevertheless, on the whole neither fully Mediterranean nor fully Nordic, but, as I think Sir Arthur Keith would say, just British.

I have tried to suggest that development of the individual depends on hereditary factors of a conservative nature, and on environmental influences which have changed with climate, food, and equipment. Thus they have affected plastic infancy, and in the end have moulded race types blending hereditary characters sometimes brought from afar with other features in which the changes of environment have had more power. A doubt persists in my mind as to the assignment of more than a somewhat limited value to taxonomic treatment of the question. It seems

worth while to think rather of regional gatherings together of physical characters.

Changes of environmental influence are usually cumulative, for natural processes are essentially irreversible even if, as in climate, there is something of a cyclic scheme of change. The cumulative change may be said to draw out the course of development more and more from its original path, thus creating a state of internal strain. No two embryos are exactly alike, and in some the hereditary units may vary towards, in others away from, a condition which would diminish that internal strain. Those varying so as to diminish the strain would probably grow best. So we have a theoretical possibility of variation of the germ limping after variation of the soma. In the case of man, whose development is so closely linked with varying balances of the influence of endocrine glands, the adjustment of the variation of the germ to the variation of the soma may not be very slow.

A special attempt has been made to suggest the part played by the development of social life in the evolution of human physique, and the importance of parental care. These factors seem in particular to have led in certain circumstances to a vast liberation of individual initiative within our human societies, especially after the development of intercourse between groups.

We must speedily undertake more and more biological observation and measurement among ourselves, and we must exercise ever more care in the treatment of our measurements. Averages of cases which are not properly homologous should not be made lest we mask the biological truth in mathematical abstractions. If our anthropological work can but go on becoming more biological, gaining insight into physiology, especially of the brain and the endocrine organs and their correlations with growth, I venture to think that racial study will develop great practical value for education, for the fight against tuberculosis and other diseases, and for race-improvement. Evolutionary race biology seems to be a hopeful sphere of work that may bring about a much-needed enrichment of public opinion on social questions, a diminution of race-arrogance, and a check on schemes that do not sufficiently allow for the mutual adaptations between diverse human stocks and diverse environments. I would ask for faith in the future of such work to bring out its great possibilities for nobler races with freer personal initiative in societies both more stable and richer in the things that are not seen.

The London School of Hygiene and Tropical Medicine.

HYGEIA, the goddess of health, daughter of Esculapius, was included among British *lares et penates* some fifty years ago, when the Public Health Act of 1875 was adopted. Since that time Great Britain has been a world pioneer in the achievements of its public health service. Attention was concentrated in the earlier years on drains and sanitation, but gradually the scope of the work of the public health authorities has widened. The results, as seen in the reduction of the death-rate to 12 per thousand and the consequent increase in the span of human life and in the health and happiness of the people, have undoubtedly had a bearing on industrial efficiency and national prosperity. But much remains to be done. Official evidence before and during the War relating to national physique and the statistics of diseases indicate the need for sustained effort in the health crusade. Even the layman can form some conception of the vast field for scientific research from the wonderful discoveries of which information is published from time to time, such as those relating to the curative power of natural and artificial sunlight and chemical methods of preventing goitre.

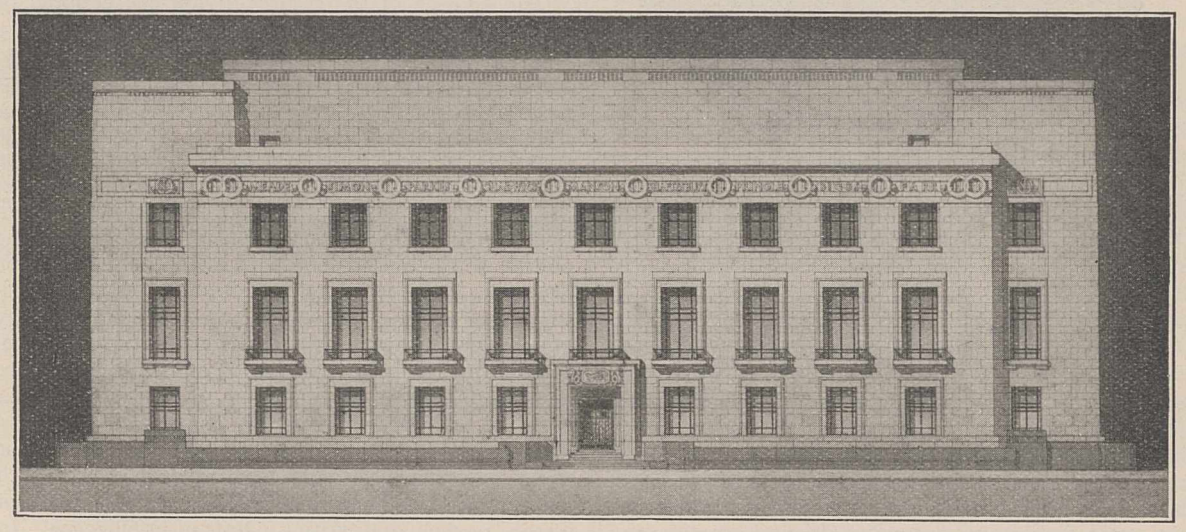

FIG. 1.—The London School of Hygiene and Tropical Medicine. Frontage to Keppel Street.

The Ministry of Health, as in duty bound, early recognised the need for extending facilities for instruction and research in preventive medicine. A committee appointed by the Ministry and presided over by the Earl of Athlone submitted a report in

May 1921 advocating the establishment of a post-graduate medical school in London and also an institute in State medicine. An expert committee was afterwards appointed to consider the recommendation as to a new school of hygiene. Financial difficulties, which may well have appeared insuperable, were miraculously removed by the generous offer of the Rockefeller Foundation to provide two million dollars (400,000*l.*) towards the cost of the building, on the understanding that the Government would accept the responsibility for maintenance, the cost of which was estimated at about 25,000*l.* a year. The appointment, in October 1923, of Dr. Andrew Balfour as director enabled definite progress to be made in the planning and organisation of the new school, the foundation stone of which was laid by Mr. Neville Chamberlain, Minister of Health, on July 7.

Such is the brief but honourable history of an enterprise representing one of the most important educational

FIG. 2.—The design of the seal adopted by the London School of Hygiene and Tropical Medicine owes its inspiration to a coin of ancient Sicily, believed to have been struck to celebrate the deliverance of one of the cities from a pestilence caused by the stagnation of the waters of the river. The design shows the deities Apollo and Artemis proceeding slowly in their chariot, Artemis driving while her brother, the sun-god, discharges arrows from his bow. The arrows are the healing rays of the sun, which drive away the malaria mists; and Artemis is beside him as the goddess who eases the pains of women labouring with child. The fruitful date palm has been added to symbolise the tropical side of the work, and at the foot is the serpent staff of Esculapius.

and scientific developments of our day and generation. For the London School of Hygiene sets a new standard in building and equipment, a standard worthy of the subject and of the Imperial city in which that subject is to be studied and investigated. The School is also the most important example—Oriental studies and history are other examples—of the new and proper method of organising higher instruction and research in selected subjects in London under the ægis of the University, a method which will inevitably be followed for many other academic and professional subjects if and when the University, through re-constitution, obtains the necessary powers and driving force.

The main frontage of the new building, of which an elevation is reproduced (Fig. 1), faces Keppel Street, looking southwards towards the impressive north façade of the British Museum, across the vacant site purchased by the Government for the University of London, and recently re-sold to the vendor, the Duke of Bedford. Return frontages, considerably longer than the main frontage, face Gower Street and Malet Street. The architects, Mr. P. Morley Horder and Mr. Vernon O. Rees, have produced a design combining simplicity and economy with dignity and the maximum of light and air. The building will be faced with stone drawn from Portland—the veritable womb of London. In addition to the teaching of hygiene in all its branches, provision has been made for tropical medicine, the London School of Tropical Medicine in Endsleigh Gardens having been amalgamated with the new institution. Altogether, the School will accommodate 250 students, including 100 students of tropical medicine. Routine instruction will be directed towards the various degrees and diplomas in public health, which form a necessary qualification for the public health service at home and abroad. The general shape of the building is a letter H closed at the south end by the Keppel Street frontage. The north court will be left open, and the south court will contain the lecture theatre. Ventilation, it is interesting to note, will be by 'natural' means, a provision for which those who have worked in buildings ventilated by 'scientific' methods will be grateful. Possibly, however, the School may itself devise new methods of ventilation, a worthy subject of hygienic research. One-sixth of the total accommodation will be reserved for research, the large lecture theatre and museum, as well as numerous class-rooms and laboratories, being regarded for the purpose of this computation as accommodation for teaching.

The division of the subject of hygiene adopted by the School has had reference to the regulations for the Diploma of Public Health, and is as follows: (1) applied physics, physiology, and the principles of hygiene; (2) chemistry and bio-chemistry; (3) immunology and bacteriology; (4) medical zoology, parasitology, and comparative pathology; (5) epidemiology and statistics; (6) principles and practice of preventive medicine, general sanitation, and administration. Dr. Andrew Balfour, in his interesting address to the Society of Medical Officers of Health on December 12, 1924, has explained the many ramifications of these subjects. Thus applied physiology includes nutrition, ventilation, illumination, physical exercise, not only in relation to adults. One of the most encouraging developments of recent years has been the increased attention to the special hygiene of infants and children. The hygienist approaches the realm of the educationist and psychologist in such questions as rest, sleep, and fatigue; the physiology of speech, reading, and writing; tests of intelligence. In his discussion of the position of chemistry, Dr. Balfour attaches little value, from the view-point of the training of the public health officers, to pure chemistry, but stresses the importance to bio-chemistry. "The future, in many directions, lies with the bio-chemist." In Division 3, the order "Immunology and Bacteriology" is deliberate. Division 4 relates mainly to tropical medicine. As regards Division 5, Epidemiology and Statistics, Dr. Balfour recognises the need for more stimulating teaching of epidemiology, and has a good

word to say for the methods adopted at Johns Hopkins University, under Prof. Frost. He admits that statistics is a "difficult and deadly subject for any one who is not blest with a gift for mathematics." Division 6, though placed last, is the largest and most important of all. Not less than thirteen special courses are grouped under the main heading. The subject is so wide and is developing so rapidly that Dr. Balfour's hint that "refresher" courses may be arranged for medical officers of health will not cause surprise.

It remains to add that the planning of the building corresponds to this comprehensive programme. Full details are given in the *British Medical Journal* (July 10, 1926). The lecture theatre (the flat roof of which will be laid out as a garden-court) and the museum (occupying 15,000 feet of floor space) are important features of the building. The library, a large and imposing room 35 feet by 120 feet, occupies the place of honour in the front of the building. There is a "Publications Department," in which provision will be made for informative and propaganda work. The Chemical Division in the north-east corner of the building will accommodate 70 students and the bio-chemical and nutritional laboratory 35 students; and there is also a number of staff and research rooms and a class-room with 70 seats. The third floor is mainly occupied by medical biology, and will absorb the greater part of the work of the old London School of Tropical Medicine in Endsleigh Gardens. It is hoped that the building will be completed in two years. T. Ll. H.

News and Views.

THE sixth annual report of the Forestry Commissioners (Sept. 30, 1925) is a document of considerable interest if only for the summary it contains of a forest policy recently enunciated by the Government. A century or two has elapsed since any Government in Great Britain can be said to have held definite ideas on the subject of what a forest policy for the country should aim at. The Government of the day has now publicly recognised that the development of such a policy is largely dependent upon State action continuously applied over a period of years, a point which has for long been beyond dispute in many European countries. It is further recognised that large areas of land in many parts of Great Britain are more suited to the production of timber than food, that private forestry should be encouraged by a system of grants, and that the systematic establishment of forest workers' holdings at the rate of 5 holdings per 1000 acres of afforestable land should be aimed at. It may be said at once that this definition of the Government's opinions and aims in this matter is admirable. If persevered in, the progress of forestry should be assured.

THE total area of land acquired by the Forestry Commissioners to Sept. 30, 1925, was 286,198 acres, of which 177,633 acres were classified at the time of acquisition as plantable. Of the plantable area 100,244 acres (56 per cent.) are in England and Wales and 77,409 acres in Scotland. The Crown Woods, *e.g.* Forest of Dean, New Forest, and so forth have now been placed under the Commissioners. When the Commission was appointed it was laid down that 150,000 acres should be afforested in the first ten years. In the Acland Report the rate of planting per year was prescribed; 50,000 acres to be planted by the sixth year. This acreage has been slightly exceeded. In some respects the laying down of rigid planting prescriptions by area is unfortunate, since the effort to maintain the planting figure may result in poor or bad work and takes no account of possible losses from drought and so forth, experiences well known to all foresters. It also results in waste. For example, in the table of cultural operations in the 1925 report, 22,615*l.* is shown as expended on planting and 9526*l.* on beating up, *i.e.* filling up plantations in which deaths have occurred. This represents nearly 40 per cent. of the planting expenditure. Forestry, like agriculture, has to face unfavourable climatic factors, but the excessive expenditure alluded to above appears difficult to justify.

THE debate, which is a usual feature of the *Forum*, in the issue for August deals with the question "Is Civilization Contagious?" and is opened by Prof. Elliot Smith with a statement of the case for 'diffusion.' The argument proceeds on the lines which he has already made familiar in putting the case for Egypt as the place of origin and centre of diffusion of culture. The reply is by Dr. B. Malinowski, who argues ingeniously that the opposition between 'diffusion' and 'independent invention' is misleading. He maintains that 'invention' is not a single event for which one single individual is responsible, but a process consisting of a series of infinitely small, infinitely many, steps for which many individuals are responsible. Every cultural achievement is due to a process of growth in which invention and diffusion have equal shares. The familiar example of the 'diffusion' of a match he regards as futile because the match does not become an element of the culture of the native, but is merely a mechanical importation. So far Dr. Malinowski's formal answer to the 'diffusionist'—in effect a compromise which would commend itself to the average anthropologist, if not to the out-and-out upholder of 'independent invention,' should there be any such, whom Prof. Elliot Smith holds up to scorn. But Dr. Malinowski's quarrel goes deeper, and it is this which constitutes the real value of his contribution to the discussion. Only in the field, he maintains, can the problem be solved as a live issue and by functional analysis. Then it appears that every aspect of culture corresponds to a specific need of human nature, to the local environment, and to the general character of given civilisation. The problem is resolved then by the writer's conclusion that diffusion never takes place; it is always a readaptation. Culture is neither

invented nor diffused, but is imposed by "the natural conditions which drive man upon the path of progress with inexorable determinism."

THE Rothamsted Experimental Station has renewed its offer to Chambers of Agriculture, the National Farmers' Union, Students' Societies and the like, to supply, during the coming winter, lectures on a variety of subjects. These lectures are offered by way of supplement to the provision already made by county education committees and agricultural colleges covering the general field of agricultural education. Coming, as they do, from workers engaged on agricultural research, the addresses should prove of extreme interest to their hearers. The agricultural sciences have now become so highly specialised, and the volume of research published daily is so great, that there is a great field of exposition open to those whose duty it is to keep in touch with new things in the branch of research with which they are specially concerned. On the other hand, the director of Rothamsted may be assumed to be fully aware of the value to the experts themselves of direct contact with the actual workers on the soil. While it is true that the pursuit of knowledge should be the sole object of the research worker, that pursuit is in danger of becoming too academic when confined to the laboratory alone. The list of subjects upon which lectures are offered is some indication of the scope of work with which the Rothamsted Station deals. Following the transference of the workers in phytopathology from Kew and Manchester, the station now deals with every aspect of plant life in health and disease, as it concerns the farmer. It may be added that a recent addition to the roll of lecturers is Mr. C. Heigham, whose thoughtful articles on the business aspects of farming were, until recently, a feature of the Saturday page in a London journal. The main headings of the syllabus which accompanies the Rothamsted circular are: soil micro-organisms; agricultural botany; agricultural chemistry; soil physics; insecticides and fungicides; entomology and mycology.

THE weather of August in the British Isles has just been dealt with by the Meteorological Office, in a tentative way, as a supplement to the *Daily Weather Report*, similar summaries being issued on the first day of each month. The promptness of the issue adds much to its value, dealing with facts while fresh to the memory. In many respects the weather of August this year is said to compare favourably with the average August weather. At Kew Observatory temperature and sunshine were both above the average, while rainfall was remarkably low—the lowest since 1899. During the last ten days of the month high barometric pressure spread over the southern districts, giving generally fine weather; at Kew there was no appreciable rain after August 21 until the early morning of September 1. About 12 hours' sunshine were enjoyed daily in south-east England on August 26-29, while day temperatures rose until August 30 when 83° and 84° were registered in London. Some abnormally high night temperatures were recorded during the latter part of the month. On the night of August 24-25 the thermometer remained well above 60° F. in many places, and did not fall below 65° F. in several parts of London. The mean temperature for the month at Kew was 64°·1, which is 2°·5 above the normal; winds were chiefly westerly and the barometer was high. Thunder only occurred on two days in London. The duration of bright sunshine at Kew was 207 hours, which is 20 hours more than the normal.

THE present status of long-range weather forecasting is dealt with by Prof. R. De C. Ward, of Harvard University, in an article written for the American Philosophical Society. The subject is being very actively considered not only in America but also in many of the European weather offices. Prof. Ward's purpose is to take stock of the subject rather than to offer any contribution to the discussion. He mentions that man's natural craving for advance knowledge of coming weather extends thousands of years back of any attempt at scientific weather forecasting. Allusion is made to the group of animal weather proverbs which have come into existence. Prof. Ward asserts that animals have no foresight which people credit them with, but these are simply characteristics of food supply and other conditions. Some credit is given to the very general forecasts based on sequences in the character of the seasons, but it is pointed out that just when a definite sequence seems to have started the chain is somehow likely to break and the sequence ends. With further and closer study something more definite may develop along this line. Allusion is made to the weather fluctuations associated with sunspot cycles, and it is stated that the results of these studies have not come up to expectations. A longer period generally recognised as having been fairly established is known as the Brückner 35-year cycle, but this may vary between 20 and 50 years. At present, and until such periodicities or variations are more fully understood, long-range forecasts definite and trustworthy cannot be based upon them. Prof. Ward, with high authority behind him, sums up the subject with the statement that the results reached are not yet generally applicable to definite seasonal forecasts, but there is, however, promise for the future.

AMONG the news items published in the *Bulletin for International Relations* (July) are the announcements of the adoption of the metric system in Greece on March 1 last, and of a decree of the Soviet Government for its introduction into Russia on January 1, 1927. A list of international scientific meetings to be held in 1927, 1928, and 1929 is also included. In 1927 there will be a congress of the International Institute for Cold, at Rome; a general assembly of the International Institute for Anthropology; a general assembly of the International Commission for the Investigation of the Air, at Prague; the sixth international Congress of Medicine, at Leyden; the seventh international Congress of Statistics, at Cairo; the fifth international Congress on Seed-Testing, at Rome, in May; the fifth international Congress of the Science

of Heredity, in Berlin (the first international congress to be held there since the War); the second Australasian Medical Congress, in Dunedin (N.Z.), in February; and a congress of the International Association of Medicinal Hydrology, in Italy. In 1928 there will be held an international Congress of Mathematics (the first to be held since the Toronto meeting in 1924), and in 1929 the seventh American Scientific Congress, at San-José, Costa Rica. The bulletin concludes with the communication, already announced in our columns (July 3, p. 21) that the International Research Council has decided unanimously to modify its statutes in order to make possible the adhesion of all States, without distinction; and to invite Germany, Austria, Bulgaria, and Hungary to join the Council.

AN important branch of engineering at the present time is the manufacture of water turbines and electric generators for operation in hydro-electric stations. In the July number of the *Journal of the English Electric Co.* an interesting account is given of a 25,000 horse-power water turbine which they have manufactured for the Sao Paulo Electric Co., Brazil, and which has now been running successfully for some considerable time in the Sorocaba Power Station. The station is on the river Sorocaba at a distance of sixty miles from Sao Paulo. The hydraulic power is converted by three 15,000 H.P. units, also made by the E. E. Co., and by this new turbine which acts in parallel with them. The new machine operates under a head of 670 feet of water and it has its rated output at 600 revolutions per minute. At full load the discharge of water is 400 cubic feet per second and the velocity of the water relatively to the vanes is 130 feet per second. As a very close speed regulation was desired the turbine guide vanes are closed in $1\frac{1}{2}$ seconds when the load varies from full load to zero. The casing has the form of a logarithmic spiral. This gives a perfect intake vortex ensuring that the water all round the guide apparatus has the same entrance velocity. The formation of disturbing eddies is therefore avoided. The efficiency is about 90 per cent.

OUTDOOR switchgear, although in fairly common use in America and on the Continent in connexion with electric power transmission, is still rarely used in this country. The account given therefore by the English Electric Co., in the July number of its journal, of the switchgear the Company has erected in the open air for connecting the electric supply systems of the Preston and Blackburn Corporations by means of high-tension transformers and a 33,000 volt cable, is of interest and value. The two necessary sub-stations are almost identical. The switchgear is carried on a light steel structure supported by a concrete plinth on which stand four 2900 kilovolt ampere transformers, the ratio of transformation being from 6600 to 33,000 volts. On the low-pressure side the circuit is broken under oil, but on the high-tension side air-break switches are employed and are mounted with 'arcing horns.' The scraping action of the type of contact employed ensures the pushing away of any sleet or snow and thus renders the switches satisfactory for use under any weather conditions. The parts are so strong that the contacts can be separated even when they are frozen together. As this type of gear can be employed up to 110,000 volts, it is probable that it will soon become common.

THE National Research Council (U.S.A.) has published, in its reprint and circular series, an address on science and engineering by Prof. W. F. Durand, of Stanford University, California, in which the author deals in an interesting manner with a familiar theme—the nature and interdependence of fundamental and applied research. He points out that each element of material progress in civilisation is the final product of a vast number of interconnecting studies, all of which converge towards this product and have their source in fundamental facts or laws of Nature. He asserts that we can never get behind these basic facts, but he treads on somewhat debatable ground when he uses the term 'explanation' to connote description of phenomena in terms of basic concepts such as 'energy,' 'electrons,' and 'quanta.' As a good professor of engineering he believes that the results of fundamental research, and, indeed, that all knowledge, find their highest expression in terms of service to humanity; and he shows how certain types of industrial research are really fundamental, although all forms of research have their place as essential elements of progress. Engineering affords some excellent illustrations of the interdependence of academic and strictly utilitarian research, and the example of aeronautics, with its dependence on mathematics, physics, mechanics, thermodynamics, and chemistry, is a particularly happy one. In conclusion, Prof. Durand pleads eloquently for more intensive fundamental research in the United States, which he believes has been relatively neglected there.

MOST of the islands in the Azores are subject to earthquakes that occasionally attain destructive violence. One of the well-known centres, though not the most active, lies in the Horta district at the eastern end of the island of Fayal. In this zone a strong earthquake occurred on August 31. In Horta, hundreds of houses were completely ruined and there were few that remained undamaged. Heavy safes were thrown out of alcoves, steam boilers were displaced, and large fissures crossed the streets. Though the earthquake was felt in the neighbouring island of Pico and even at Ponta Delgada in the island of St. Michael, the disturbed area, as in most volcanic regions, seems to have been small, considering the strength of the shock at the epicentre.

THE following awards for the year 1926–27 have been made by the Salters' Institute of Industrial Chemistry and approved by the Court of the Company: Fellowships have been renewed to—Mr. H. S. Pink, University College, Nottingham, and University of Oxford (fellow, 1924–25, 1925–26), at the Massachusetts Institute of Technology; Mr. V. E. Yarsley, University of Birmingham (fellow, 1924–25, 1925–26), at the Polytechnic, Zürich; Dr. R. Campbell, Arm-

strong College, Newcastle-upon-Tyne, and University of Oxford (fellow, 1925–26), at the Department of Chemical Engineering, University College, London. Fellowships have also been awarded to—Mr. E. A. Bevan, East London College, University of London; Mr. R. M. Deanesly, University of Oxford; Mr. R. Edgeworth-Johnstone, College of Technology, University of Manchester; Mr. H. B. Spalding, University of Oxford. The Salters' Institute has also awarded fifty-one grants-in-aid to young men employed in chemical works to facilitate their further studies.

AN interesting addition has just been made to the exhibits in the electrical communication section of the Science Museum, South Kensington, by Messrs. Television, Ltd., who have lent to the Museum the transmitting portion of the original apparatus used by Mr. J. L. Baird in experiments which led him from the wireless transmission of outlines in 1925 to the achievement of true television nine months later, when, on January 27, 1926, the transmission of living human faces with light, shade, and detail was demonstrated before members of the Royal Institution. The subject of television was referred to in an article in our columns on July 3. The apparatus now placed on exhibition at South Kensington includes the original ventriloquist's head used in Mr. Baird's experiments, the revolving dial with lenses, the slotted disc which, revolving at high speed, interrupted the light reflected from the head, another revolving interrupter and the cell container with the aperture through which the flashes of light reach the sensitive cell.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—An assistant fishery officer in the Fisheries Department of the Ministry of Agriculture and Fisheries—The Secretary of the Ministry, 10 Whitehall Place, S.W.1 (September 20). Inspectors under the Agricultural Wages (Regulation) Act, 1924—The Secretary, Ministry of Agriculture and Fisheries, 10 Whitehall Place, S.W.1 (September 24). A head of the Department of Commerce of the Witwatersrand Technical Institute—The Secretary, Office of the High Commissioner for the Union of South Africa, Trafalgar Square, W.C.2 (September 30). An assistant in the Essex Museum of Natural History, Romford Road, Stratford—The Principal, West Ham Municipal College, Romford Road, E.15 (September 30). An evening lecturer in botany at the West Ham Municipal College, Romford Road, E.15—The Principal (September 30). A pathologist to the Lancashire Asylums Board—The Clerk of the Lancashire Asylums Board, County Offices, Preston (October 1). Research chemists at the Chemical Research Laboratory, Teddington—The Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, Westminster, S.W.1 (October 7). An assistant master for engineering and workshop practice at the Kingston-upon-Thames Technical Institute—The Principal.

Our Astronomical Column.

SUSPECTED COMET.—Mr. Wilk, assistant at Cracow Observatory, who discovered a comet last year, has sent a telegram to the I.A.U. Bureau at Copenhagen announcing his detection of another cometary object of the sixth magnitude on September 1, $21^h\ 46^m{\cdot}0$ U.T., in R.A. $15^h\ 53^m\ 12^s$; N. Decl. 3° 55′ (position referred to equinox of 1855). The motion was stated to be direct (that is, in the direction of increasing R.A.), and according to the wording of the telegram it reached the extraordinary amount of one degree in four minutes, but it is doubtful whether this is the correct interpretation. If so, the comet was very near the earth, and no forecast of its position is possible until more data are to hand. The writer of this note swept for a few degrees round the given position on September 4 without detecting any bright comet.

FIREBALL ON AUGUST 13.—Mr. W. F. Denning writes: "A large fireball was seen from various parts of England on August 13 at $9^h\ 13^m$ P.M. Among other places it was observed from Alford, Linc., Palling, Norfolk, Keynsham, near Bristol, and Derby. The meteor gave the impression of a brilliant rocket; for it illuminated the landscape and sparks followed the head along its somewhat lengthy course. As viewed from Derby it was described as being of an incandescent blue colour with a tail of similar tint and golden sparks. Another person says it emitted an intense bluish-white hue like lightning and that it vividly illuminated the country. I have compared the data and find that the radiant point is indicated at 303° – 13° near α Capricorni, and that the meteor traversed a path of about 84 miles, falling from 62 to 33 miles in height—velocity about 25 miles per second. The direction of flight was from south by east to north by west, and the meteor passed from over Huntingford to near Doncaster. The radiant point is a well-known one and has been often observed in July and August supplying slow and brilliant meteors."

THE PROBLEM OF 'ISLAND UNIVERSES.'—The true interpretation of spiral nebulæ, either as comparatively small bodies occurring merely as outlying members of our Galaxy, or, on the other hand, as very remote systems comparable both in size and nature with the Galactic system itself, still remains a matter of controversy. An important contribution to the problem is made by Dr. Hubble in the *Astrophysical Journal*, vol. 63, p. 236, in which a critical and detailed analysis is given of the naked eye spiral Messier 33, based on photographs taken with the great 100-inch reflector. The high resolving power of this instrument shows no difference between the images of so-called condensations and those of ordinary stars of the same magnitude. Ritchey's description of these objects as "nebulous stars" appears therefore to be no longer tenable. Numerous nebulæ, novæ, and variable stars have been discovered by Dr. Hubble in Messier 33, including 35 Cepheids. The distance as derived from the period-luminosity relation among the latter is about 263,000 parsecs. That this distance is of the right order of magnitude is confirmed by evidence from the novæ and from the luminosity function for the brighter stars. Dr. Hubble considers Messier 33 to be an isolated system of stars and nebulæ, far beyond the limits of the Galaxy; but as being more comparable in size and luminosity with the Magellanic clouds than with our own system.

Research Items.

REMISSION OF SINS AT THE SHRINE OF A MOSLEM SAINT.—A description of a fair at Pakpattan at the tombs of Bâbâ Farîd Shakarganj, which is quoted in the *Indian Antiquary* for August, contains several points of interest to the students of religious belief. The great attraction of this annual fair is the opening of the Gate of Heaven. On the death of the Bâbâ, who is credited in story with wonderful powers during his lifetime, it was published far and wide that whoever passed through his tomb between sunset and sunrise on the new moon in August would be forgiven the sins of the past year, and the fair was established for the benefit of the faithful attending at the tomb for this purpose. The fair is attended by worshippers drawn from districts so wide apart as the North-West Frontier and the United Provinces. On the final night when the gate is to be opened, all pilgrims collect outside the gates of the town, which are closed. On the signal by rocket that the sun is set, they are admitted to the town and all night long pass in single file through the tomb. At sunrise the door is shut. On one occasion the police used light switches to strike the people in order to hasten the movements of the crowd. The people, instead of avoiding the blows, courted them, and on inquiry as to the reason, it was stated that the switches represented the sword blades forming the legendary bridge between earth and heaven on which the feet of the faithful are cut, whereas the wicked fall between the gaps in the bridge into hell below. Those, therefore, who were hit by the police switches considered that they had had their feet cut by the swords of the bridge and were doubly sure of the forgiveness of their sins.

INTELLIGENCE AND FAMILY HISTORY. — Some interesting data bearing upon the question of how far superior intelligence is a family characteristic have been collected by Miss Grace Allen as the result of an investigation of 48 families to which belonged a number of children selected as the result of psychological tests by members of the Teachers' College, New York. The results have been published in *Bull.* 25 of the Eugenics Record Office of the Carnegie Institution of Washington. All the children were of exceptionally high character intellectually, and the study involved the more remote history of the family, present conditions, occupational and home ratings, physical and temperamental traits and birth conditions. Of these families 70 per cent. were Jews, and of these 20 per cent. of German extraction, and 10 per cent. more German on one side of the family. Only one child came of American stock on both sides, and in only three families were all four grandparents American born. As regards occupation, 70 per cent. of the fathers were professional men, and 25 per cent. did clerical or semi-intellectual work; 25 per cent. are college graduates, a frequency twelve times higher than in the population at large. Brothers and sisters and cousins tested for intelligence scored high. The fecundity was low, being about 0·8 of a reproducing child to each parent. First births occur twice as commonly as in the general population; but this is due to the fact that the intelligent groups have an exceptionally high population of first-born children only. The fathers are above the average age because this class marries late. Physically the families belong to a fine stock, being long lived and robustly built. The children show few physical defects. In a preface, Dr. Charles B. Davenport sums up the results of the investigation as showing that the highest intelligence comes out of a stock that is highly developed on both sides.

GLASS-MAKING IN ANCIENT EGYPT.—The technique of the manufacture of glass vases in ancient Egypt is obscure. Sir Flinders Petrie has suggested in connexion with the examples discovered by himself at Tel-el-Amarna, the use of a rod and a core of sand dipped into melted glass, while Mr. Harry Powell in the "Encyclopædia Britannica" suggested alternatively that they were blown. Mr. James H. Gardiner in *Glass* for July considers that the true method of production must differ from anything that has yet been suggested, basing his view on the examination of a number of examples of the XVIIIth Dynasty. The softening or plastic temperature is about 900° C., not a great deal below that of good English flint glass. Some, however, have been drawn from material which would have needed quite 1000° C. to form. In the case of a fish-shaped vase from Tel-el-Amarna, the body is a well-melted blue soda metal with fine seeds. The tail portion is solid and has been made and ornamented first and then squeezed on to the soft body. The indentation of the flat-nosed tongs used for holding can be distinctly felt. The coloured-glass pattern was made by threading coloured glass on to the surface. Notwithstanding the weighty negative evidence of an absence of any indications of blowing tools or fragments showing clear inside surfaces, the author is strongly of the opinion that the glass objects of the XVIIIth Dynasty show the beginnings of fabrication of glass vessels by blowing, which afterwards developed into the blown ware of the Greek and Roman period. It is suggested that the fact that in all cases there was a circular opening in the neck showing abrasion, as if a metal rod had been introduced and withdrawn, may have been due to the use of a metal funnel to introduce hot sand while the material was soft, and that the object was then buried in hot ashes to cool slowly.

THE GREAT RIFT VALLEY.—In a paper in the *Geographical Journal* for August, on the Nyasaland section of the great Rift Valley, Dr. F. Dixey advances the view that in early Cretaceous or possibly late Jurassic times, the initial uplift in the Nyasa region took the form of a gentle anticlinorium, or large anticline, and that the more or less meridional troughs so produced were occupied eventually by rivers. At a later date rift faulting began, and continued intermittently through a large part of Tertiary and Quaternary times. Intersecting faults also extended into the regions bordering the main rift on both sides. The volcanic history of the area seems to have been largely confined to late Tertiary or early Quaternary times. Dr. Dixey finds no evidence to support the hypothesis of a marine sedimentary phase of Oligocene age. Lastly, he gives reasons in favour of the rift-faulting of the region being due to long-continued tensional stresses rather than to compression. These are the absence of thrusts and folds and the development of much block faulting; the occurrence of subsidiary rifts parallel with the main rift; the existence of a reticulated system of rift valleys; low-step faults extending into the middle of the rift valley floor; and the successive tilting of the floor of the northern end of the rift in one direction.

TERTIARY FOSSILS FROM JAPAN.—No less than six papers on the tertiary mollusca of Japan, from the

pen of Prof. Matajiro Yokoyama, appear in the first volume of the Journal of the Faculty of Science of the Imperial University of Tokyo. Most of these fossils come from the central districts of the main island of Japan, but some are from the oil-fields in the north-western part of the "Main Island of Hokkaido" (formerly known as Yedo). Prof. Yokoyama's communications total 87 pages illustrated by 19 plates, which are very good, but not quite equal to the efforts of the Japanese artist at his best. The text, beyond brief statements as to the position and age of the respective beds in which they occur, is confined to systematic descriptions of the species, many of which are described as new.

BAXTER BASIN GAS-FIELD, WYOMING.—Mr. Julian D. Sears contributes an interesting account of the geology of the Baxter Basin Gas-field, Sweetwater County, Wyoming, in *Bulletin* 781-B of the United States Geological Survey. This field was first proved in 1922 by the completion of two wells of large yield; previously, drilling on the Rock Springs anticline, of which the Baxter Basin occupies structurally the highest part, had resulted in little or no success; even now there seems to be small prospect of oil being found in commercial quantity. Gas is found in commercial quantity, however, in each of the three domes developed along the crest of the main structure, and is produced from the Upper Cretaceous Frontier and Dakota sandstones. Each dome has its own gas-pool, there being no single continuous pool common to all three as they are separated by structural depressions and by faults that offset the reservoir beds. Twenty-three wells had been drilled in this field up to the time of survey; these ranged from 1000 to 3400 feet deep, finding the Frontier sands at depths from 1800 ft. to 2000 ft., and the Dakota sands at depths from 2500 ft. to 3400 ft., according to the positions of the wells concerned. Some remarkable yields are recorded: one well gave 2,000,000 cubic feet per day from the Frontier and 70,000,000 cubic feet from the Dakota; another well found water in the Frontier but yielded 21,000,000 cubic feet of gas per day from the Dakota; other yields from the Dakota (unquestionably the richest sand in the field) are from 17,000,000 cubic feet to 35,000,000 cubic feet daily. Water occurs high on the flanks of two of the productive domes, thus leaving very little room for an intervening oil layer between it and the gas; this is one of the reasons dispelling any hope of commercial oil production from this field.

CYCLONES OVER CEYLON.—Cyclonic movements in Ceylon are dealt with by Mr. A. J. Bamford, the superintendent of the Colombo Observatory, in the *Ceylon Journal of Science*, vol. 1, part 1, in continuation of the series that have appeared in the past in the bulletins of the Colombo Observatory. Any discussion of the movements of cyclones wherever dealt with is of general interest, as cyclones are so decidedly the centres of action with respect to the weather both over land and sea. In the discussion several storms are analysed, and much information can be gleaned as to the main seat of control in that part of the globe. Other special features are dealt with in detail, especially the heavy rains over Ceylon of September 29-30, 1924, falls up to 12 inches being reported which occasioned floods in many places. The weather over the island at the time was of the usual south-west monsoon type; the fall of temperature on September 29 is said to be the result and not the cause of the rains. Maps are given showing the rainfall over Ceylon.

CLIMATOLOGY OF FALMOUTH.—Weather observations at Falmouth for the year 1925 and the mean values for 55 years, 1871–1925, have just been issued by Mr. J. B. Phillips, the superintendent of Falmouth Observatory. The observations are of considerable value, as they show great equability of the climate throughout the year. The mid-winter month January had the day maximum temperature between 50° F. and 54° F. on 24 days, and there was only one day with the temperature below 45°; the minimum or night temperature was only below 40° on six days and on three days was above 50°. The mean temperature for January was 3°·4 above the average. In November and December, when periods of exceptionally cold weather were experienced over Great Britain, the relation of Falmouth to other parts of the country is interesting. The mean temperature for the year was 51°·5, which is 0°·7 above the normal; the warmest months with relation to the average for 55 years were January and October, both of which exceeded the average by 3°·4. The total hours of bright sunshine in the year were 1819, which was 69 hours above the mean, and it was the highest for the year since 1911, when the sun shone for 2056 hours. During the first six months of 1925, Falmouth had 43 per cent. of the possible duration of sunshine, while that for the British Isles was 35 per cent. For June, Falmouth had 77 per cent. of the possible duration of sunshine, while for the British Isles it was 50 per cent. The daily average sunshine at Falmouth for the several seasons was: spring 5·41 hours a day, summer 7·88 hours a day, autumn 4·33 hours a day, winter 2·36 hours a day. The total rainfall for the year was 49·77 in., which is 4·01 in. more than the mean. The outstanding feature of the year was the rainless period from May 29 to July 3, absolutely no rain falling in June, while the mean for 55 years is 2·24 in.

THE CRYSTAL STRUCTURE OF MAGNESIUM PLUMBIDE.—With the publication of J. B. Friauf's results on the crystal structure of magnesium plumbide (Mg_2Pb), in the *Journal of the American Chemical Society* for July 1926, the crystal structures of the three intermetallic compounds which magnesium is known to form with silicon, tin, and lead, are now completely determined. The plumbide, prepared by melting the calculated amounts of magnesium and lead under a protective layer of sodium and potassium chlorides, was ground to powder under kerosene, and a sample, covered with a little paraffin, rotated during exposure to radiation from a molybdenum target. The powder diffraction pattern was photographed, and the unit cell found to contain four molecules. The position of the atoms corresponded with the calcium fluoride arrangement.

SPIRIT THERMOMETERS.—The August issue of the *Journal of Scientific Instruments* contains an article by Mr. W. F. Higgins, of the National Physical Laboratory, of considerable importance to the makers and users of spirit thermometers. It has been noticed that the readings of certain spirit thermometers when placed in melting ice have decreased with age at rates of the order of 1° F. per month. Experiment has shown that the decrease is not due to loss of spirit, through minute cracks in the glass or to change of volume of the glass, but to the presence of small quantities of acetone in the methyl or ethyl alcohol used in the instrument. Ten per cent. of this impurity is sufficient to cause a lowering of the ice point at the rate of 1° F. every ten days for the first few months after the thermometer is made. The effect appears to be due to the polymerisation of the acetone under the influence of light.

Excavations in Kent's Cavern, Torquay.

AT the Southampton meeting of the British Association last year, a Committee was appointed to co-operate with the Torquay Natural History Society in investigating the important palæolithic site at Kent's Cavern, made famous by the researches of McEnery, Buckland, and Pengelly. For some time previously the future of the cave, which is in private ownership, and the possibility of dispersal to unknown destination of relics of antiquity which might be of the greatest moment for the early history of man in Britain, had been a source of anxiety to the local scientific society and to archæologists generally. It was hoped that the British Association Committee would be able to some extent to mitigate the dangers of the situation; but at the time of its appointment there seemed little hope of immediate excavation, and at the most it was hoped that it would hold a watching brief for archæology and ensure that any specimens of interest or importance to science which might come to light should, at least, be recorded and if possible made available for study. Early last winter, however, leave was obtained from the proprietor for a preliminary examination of that part of the cave known as the 'Vestibule.' Funds were raised from the British Association, the Royal Society, the Society of Antiquaries, and a fund for the employment of ex-service men; but the greater part of the work has been carried out voluntarily by members of the Torquay Natural History Society. A summary of the results of these excavations is contained in a report of the Committee which was presented at the Oxford meeting of the Association.

'The Vestibule,' which was selected for excavation on the advice of Prof. W. J. Sollas, is a chamber some 40 ft. by 32 ft., into which the northern entrance to the cavern leads. A trench was dug along the entire length of the northern wall slightly overlapping into the 'Sloping Chamber' and passing at its eastern end under the Magdalenian hearth discovered by Pengelly in 1866, which is known as the 'Black Band.' A beginning of a trench along the east wall in the direction of the entrance was also made. The depth of the trench varies from 2 ft. 6 in. to 13 ft. according to the nature of the deposit. The area which produced the greater part of the finds was near the east wall. Heavy blocks of limestone were present throughout. At each end of the trench crystalline stalagmite has appeared at the bottom of the excavation, but it is too early to say if this represents portions of a stalagmite floor.

The cave earth is quite unstratified and the fauna identical with that found by Pengelly at the higher levels. No hearths or workshops were found, but 135 flints scattered here and there have been recovered. Nearly all are patinated a dull white. Omitting waste fragments and neuclei, they fall into two classes: end scrapers and 'blades,' the latter being about 80 per cent. of the total. The end scrapers are of the usual type with primary flaking along the length of the implement, terminating at the broader end in steep, fanwise retouches producing a convex scraping edge. The reverse is a flake surface. The implement is in the Aurignacian tradition. The 'blades' have primary flaking along the length of the implement with two facets meeting in a carinated median line, or three facets, when the central facet makes a flat ridge. This would appear to be an industry of simple unretouched blades, and corresponds to the implements collected by Pengelly from the higher levels. The absence of bone, horn, and ivory implements suggests that it is not true Magdalenian; the absence of Chatelperron and Gravette points that it is not true Aurignacian; and of burins that it is not either Aurignacian or Magdalenian. Certain similarities to Solutréan are probably intrusive. It is, however, certain that we have here a culture of Upper Palæolithic type.

The abundance of remains of the horse would indicate a steppe climate suggestive of the Aurignacian and Solutréan periods of southern France, but reaching England at a later date. The study of the fauna suggests that the cave earth was in process of formation when the upper part of the base level and the lower part of the middle levels were laid down in Mother Grundy's Parlour at Creswell, of which the upper middle level roughly corresponds to the Black Band of Kent's Cavern. The deposits recently examined in the Aveline's Hole in the Mendips seem to correspond to the granular stalagmite excavated by Pengelly.

In a skull found in a crevice outside 'the Vestibule' Sir Arthur Keith finds a close correspondence in the palate and teeth to those of the human jaw found in the granular stalagmite. It is brachycephalic and compares closely with two brachycephalic skulls found at Aveline's Hole, also associated with an industry of simple unretouched blades.

Irish Limnology.[1]

ALTHOUGH the study of lake life has received considerable systematic attention by other countries, especially on the Continent and in the United States, there had been no definite institution set up for that purpose in Great Britain or Ireland until the year 1920. It remained for the War to direct attention to our lack of knowledge of British lakes and their possible economic value; and, as a direct outcome of consultations at that time, a limnological station was established in August 1920 on the river Shannon, one mile from the northern end of Lough Derg, Ireland being considered the most suitable country in which to tackle the problem on account of its valuable inland fisheries and large area of fresh water.

The first report from the limnological laboratory by Mr. R. Southern and Mr. A. C. Gardiner, now before us, deals chiefly with the Crustacea in the plankton of Lough Derg and the river Shannon. The research, which included two full years, 1921 and 1922, was carried out with a thoroughness and attention to detail worthy of the greatest praise. Five to seven stations were worked with regularity, the positions being chosen so that information could be obtained on the plankton of the Shannon River itself and of the northern end of Lough Derg in regions outside and within the effect of the river's current and in special localities in which the effects of wind action might be shown. The technique of the plankton collecting was carefully worked out, and it is satisfactory to note that the results are based on collections made by horizontal hauls, although vertical hauls were generally taken at the same time. A great deal of attention was devoted to making these horizontal hauls as uniform as possible, and an ingenious method of

[1] "Fisheries, Ireland, Sci. Invest.," 1926, i. Reports from the Limnological Laboratory. I. The Seasonal Distribution of the Crustacea of the Plankton in Lough Derg and the River Shannon. By R. Southern and A. C. Gardiner. Pp. 1-170. Plates I.-XV. Text figs. 1-4.

drifting from an anchored boat until 100 yards of greased rope had run off a reel, and then rowing back through this 100 yards in a given time, was adopted, and ensured, so closely as is practicable, that fairly equal volumes of water were filtered on each occasion. Concurrently with the plankton collecting, observations were made of the following chemical and physical factors—temperature (air and water), wind, rainfall, water level, transparency of the water, hydrogen ion concentration, dissolved oxygen and complete chemical analysis of the water.

Examination of the physical and chemical conditions has shown that Lough Derg differs from many lakes of which the features have been described on the Continent and in America, in that its waters are practically homogeneous from surface to bottom throughout the year, any evidence of a thermocline, and hence marked changes between surface and bottom oxygen content, being absent. This, in Southern and Gardiner's opinion, can be accounted for by the general shallowness of the lake (rarely more than 20 feet in the northern half, although the southern end is deeper with soundings as great as 119 feet), its narrowness, and hence continual change of the body of water flowing through it and the general mixing action of winds over the shallow water. In consequence, all the water of the lake is capable of supporting an abundance of living plankton organisms and of fish life. The ratio $\frac{Na+K}{Ca+Mg}$ is low: the phytoplankton is characterised by the relative scarcity of the Desmidiaceæ and dominance of the Diatomaceæ. This supports Pearsall's theory that if the above ratio is low the conditions favour the growth of diatoms, and, if high, of Desmids. It was also notable that large numbers of different species occurred together, at the same time, in great abundance. A further report on the phytoplankton is to be published.

The distribution of the crustacean plankton is considered from all aspects—seasonal and diurnal, both horizontally and vertically. In the horizontal distribution great stress is laid on the wind as a factor in causing irregularity, and the detailed discussion of the effects of winds is being kept for a subsequent report. Of the crustacea, *Daphnia longispina* was the dominant form, though *Bosmina coregoni*, *Leptodora Kindtii* or *Diaptomus gracilis* were most prevalent at times.

The importance of plankton crustacea as food for fish is discussed. Of the fish present in the lake, the Pollan, *Coregonus elegans*, is a plankton feeder throughout its whole life; these crustacea were also found to be an important constituent of the diet of the fry of pike, tench, rudd, bream, and perch. A correlation between the growth-rate of perch fry and the abundance of crustacea is given. It is interesting to see that to a certain extent big trout were also found to be feeding on plankton. The fact that these sporting fish will feed voraciously on small entomostraca is perhaps not generally known. In this respect it is interesting to direct attention to an experiment carried out at the Jersey waterworks showing the remarkable growth of young trout which fed on the abundant crustacean plankton present in the filter beds.[2]

It is sad to see that, after such a good beginning, the limnological station on the river Shannon is now closed down. It is necessary that such well-planned work should be carried out through the course of many years before the true significance of many of the seasonal changes in the plankton community can be fully understood and the foundations laid for a close study of the actual fish-producing power of these lakes.

Messrs. Southern and Gardiner have made an important addition to the many valuable works that have been published from time to time by the fisheries of Ireland. F. S. R.

[2] "The Biology of Jersey Waterworks," by W. Rushton, P. A. Aubin, and A. J. Jenkins. Published by the Institution of Water Engineers, 1925.

Studies on the Origin of Cultivated Plants.

THE history of cultivated plants is a subject which has attracted many botanists, and numerous theories of their origin from one or more wild prototypes have been published. Until recently the conclusions of Alphonse de Candolle have been accepted with a minimum of critical revision. The great increase in genetical research and the marked desire of many geneticists to link their studies with other aspects of biology is, however, leading to renewed interest in the taxonomic and geographical history of our common cultivated plants. Much new material has been accumulated and a few geneticists are even devoting time to collecting in person cultivated, feral, and wild examples of the genera and species they are studying in experimental ground and laboratory.

Prof. N. Vavilov, Director of the Institute of Applied Botany and New Cultures, Leningrad, is well known in Great Britain by the numerous important works on genetics and allied subjects which he has published. In a paper which has recently been received [1] he deals in a decidedly original manner with the origin of the common cereals and a few other widely cultivated plants. The conclusions reached are very largely based on the researches carried out by Prof. Vavilov and his assistants in Central Asia and the Nearer East in the years since the War. In addition, many thousands of seed samples have been obtained from all parts of the world and grown at one or other of the experimental stations under the control of the Institute. While it is certain that many details have still to be discovered for all the groups studied, there is no doubt that important problems have already been solved, and that further applications of the new methods will aid in the elucidation of many obscurities in the past history of all species and races which have been so long in cultivation that not even archæological researches can alone prove their origin.

The law of homologous series, expounded by Prof. Vavilov in an able paper in the *Journal of Genetics*, **12**, 47, 1922, is applied here with the purpose of finding the geographical centre, or centres, of maximum varietal diversity within what is accepted as a "Linnean species." The data are set forth in tables and illustrated by exceptionally clear maps in the Russian text, to which is attached an almost full English translation. The results are comparable with the periodic classification of the chemical elements in that not only are the known variations classified, but also the existence of undiscovered varieties is postulated. In addition to the usual 'characters' of the taxonomist and morphologist, physiological characters, such as immunity to diseases and seasons of vegetative activity and of flowering, and cytological and genetical data are freely used. It was found that even for cultivated plants the variations are not haphazard in their geographical distribution, but that they occur about well-marked centres. The immense diversity of spring and winter forms of soft and club

[1] From *Bulletin of Applied Botany and Plant Breeding*, **16**, 2, 1926, Leningrad.

wheats is concentrated in the mountainous districts of south-west Asia, while the polymorphism of the durum wheats is most marked in North Africa. Two centres of origin for the barleys are indicated in Abyssinia and south-east Asia. Cultivated oats are undoubtedly of polyphyletic origin, and five geographical and genetical groups are established. South-west Asia is recognised as the chief centre of diversity of rye. There is no reason to regard *Secale montanum* and *S. fragile* as progenitors of cultivated rye. Both oats and rye probably entered cultivation simultaneously and independently in different localities, primarily as weeds in crops of wheat and barley. Flax is referred to two principal groups: a large-seeded, large-flowered group connected with the Mediterranean, and a small-seeded, small-flowered one peculiar to south-west Asia. A third group may be centred in Abyssinia. It is shown that the mountainous districts of Asia and the Mediterranean region, being the centres of varietal diversity of nearly all the most important agricultural crops, were probably also the home of primeval agriculture.

The final paragraphs of Prof. Vavilov's stimulating paper form a fitting conclusion to this notice of his work: "Evolution proceeded in time and space, and only by coming near the geographical centres of the origin of forms, by establishing the links connecting species, shall we be able to master the synthesis of Linnean species (considering them as systems of forms). Only systematics and the knowledge of the geography of plants enable the geneticist to select consciously the initial forms for his crosses and to solve problems of experimental phylogenetics. The problem of the origin of species is thus considered as the problem of the origin not of separate varieties, which in Darwin's opinion differentiated into individual species, but of complex systems, such as are true Linnean species.

"As it follows from the above, the solution of the problem of the origin of species lies in a synthesis of thorough investigations of separate groups of plants by the differential systematical methods, by that of botanical geography (in the sense of establishing the centres of the origin of forms), and the methods of genetics and cytology. Only in using systematics, differential geography, genetics and cytology, can we find a way to the strongholds hiding the origin of species."

W. B. TURRILL.

University and Educational Intelligence.

LEEDS.—With the co-operation of the International Education Board of New York, an exchange of posts for the academic year 1926–27 has been effected between Prof. Olis F. Curtis, professor of plant physiology, Cornell University, Ithaca, New York, and Dr. W. H. Pearsall, reader in botany, the University, Leeds. Dr. W. H. Pearsall sailed for America in time for the International Congress of Plant Sciences, which was being held in Ithaca during August, and to which he communicated an account of his investigations of the aquatic flora of the Lake District, England. Prof. Curtis, who arrives in Leeds this month, has published interesting papers in many fields of plant physiology, but is best known for his work upon the channels in which food substances travel through the plant.

DR. NOEL J. G. SMITH, of the Department of Botany, University of Aberdeen, has been appointed professor of botany in the Rhodes University College (University of South Africa), Grahamstown. Dr. Smith was educated at the University of Edinburgh and at Cambridge.

BY the will of the late Sir John Williams, Bart., President of the University College of Wales and of the National Library of Wales, who died on May 24, leaving estate of the gross value of 123,742*l*., the residue of the property, which will amount to nearly 100,000*l*., is bequeathed to the two institutions of which he was president.

"MOTIVATION OF ARITHMETIC" is the title of a sixty-page report by Mr. G. M. Wilson, professor of education, University of Boston, published as Bulletin 1925, No. 43 of the United States Bureau of Education. It is based on some five thousand replies received from teachers in all parts of the country, and leads to the general conclusion that arithmetic, in spite of isolated attempts at motivation, is still largely a formal subject. Prof. Wilson's point of view is indicated by the question he urges teachers to think over: Should life be brought in to illustrate arithmetic, or should arithmetic be subordinated and become a means for the interpretation of life? There is, as he says, much work ahead for those who would realise the ideal of school work on a real life basis. Meanwhile his pamphlet with its examples of "actual life situations," of life situations used as a basis for school exercises, games, game devices, and other devices, representative of methods used by the most progressive and intelligent teachers in the public schools of the United States, will help substantially towards approximating school practices to his ideal. The bulletin is a good example of the levelling-up work undertaken by the United States Bureau of Education through making widely known among teachers the practices of the best.

THE report on the work of the Department of Petroleum Technology of the Sir John Cass Technical Institute for the session 1925–1926 has been issued. This department was established about five years ago to provide technical instruction for those engaged in or desirous of entering the petroleum industry. The courses include lectures on petroleum technology, on the properties, applications, and examination of petroleum, on the chemical and physical properties of petroleum, and on the applications of engineering, also mechanical drawing; provision is made for those possessing no previous knowledge of experimental science to take the preliminary course of elementary chemistry, elementary physics, and practical mathematics. The record for the session shows satisfactory progress, in the case of the petroleum lectures, Part 1, there being no less than 90 class entries engaged in all for 1343 'student hours.' The report comments on the educational value of kinematograph films of the petroleum industry, two of which were exhibited during the session; such films enable students "to see in true perspective the ramifications of the industry and the difficulties associated therewith." Those responsible for directing the work of this department deserve much credit for the valuable work accomplished in a comparatively short space of time. A strong feature of the organisation is the existence of the consultative committee composed of recognised experts in the industry; this committee is not only of use in advising on work-schedules, but, acting in liaison with the principal oil companies in London, it also ensures what is so vital in all academic treatment of petroleum technology—constant contact with the industry itself.

Contemporary Birthdays.

September 12, 1851. Sir Arthur Schuster, F.R.S.
September 14, 1849. Prof. Ivan Petrovitch Pavlov, For. Mem. R.S.
September 16, 1859. Mr. Basil Mott, C.B., M.Inst.C.E.
September 17, 1859. Dr. Frank Dawson Adams, F.R.S.
September 18, 1854. Sir Richard Tetley Glazebrook, K.C.B., F.R.S.

Sir ARTHUR SCHUSTER was born at Frankfort-on-Main, and he was educated at the University of Heidelberg, and at Owens College, Manchester. Professor of physics in the University of Manchester, 1888–1907, he was a secretary of the Royal Society from 1912 until 1919, and president of the British Association at the Manchester meeting of 1915. As chairman of the executive committee of the National Physical Laboratory for the six years' period, 1919–1925, Sir Arthur rendered important services, not only to the institution, but also to science in general. It is worthy of recall that in his article "Spectroscopy," in the "Encyclopædia Britannica" (11th edit., 1911), Sir Arthur remarks in a footnote that he believes he was the first to introduce the word 'spectroscopy' at a Royal Institution lecture. This discourse was delivered January 28, 1881, under the title, "The Teachings of Modern Spectroscopy."

Prof. I. P. PAVLOV, the distinguished Russian physiologist, is a foreign member of the Royal Society, and he was Nobel laureate in physiology and medicine for 1904. Prof. Pavlov's earlier researches related to the physiology of the circulation, and especially the nerve supply of the blood-vessels. Soon, however, he was concerned in chief with the physiology of digestion, establishing new methods of procedure in the examination of functions, and deducing conclusions which have proved of fundamental importance in the whole study and range of the subject. In 1915 Prof. Pavlov was awarded the Copley medal of the Royal Society.

Mr. BASIL MOTT received his early technical training at the Royal School of Mines. Mr. Mott was president of the Institution of Civil Engineers in 1924.

Dr. F. D. ADAMS is emeritus dean of the Faculty of Applied Science, and Logan professor of geology in McGill University, Montreal. Born in that city, he was educated at the High School there, graduating at McGill. He is Hon. LL.D., Toronto. Dr. Adams has conducted many researches in economic and experimental geology. An account of one of these (in collaboration with Dr. J. T. Nicolson), entitled "An Experimental Investigation into the Flow of Marble," was published in the *Philosophical Transactions* for 1901.

Sir RICHARD GLAZEBROOK, foreign secretary of the Royal Society, was educated at Liverpool College, and at Trinity College, Cambridge, graduating 5th wrangler. Sometime assistant director of the Cavendish Laboratory, he was afterwards principal of University College, Liverpool, from 1898 until 1899, retiring to become director of the newly established National Physical Laboratory, a post which he filled with acumen and distinction for fifteen years. He is now chairman of the executive committee of the Laboratory. Sir Richard was awarded the Hughes medal of the Royal Society in 1909. Author of a number of valuable text-books, the editorship of the "Dictionary of Applied Physics" is his latest service to scientific publications of permanent value.

Societies and Academies.

PARIS.

Academy of Sciences, July 26.—Gabriel **Bertrand** and M. **Mâchebœuf**: Nickel, cobalt and diabetes. Injections of saline solutions containing small quantities of these two metals in some cases of diabetes proved to be without effect; in others, there was a marked improvement. Administered by the mouth, in one case of diabetes, the amount of insulin injected daily could be reduced by 25 per cent.—**Rateau, Leroux** and **Bourgeat**: The experimental determination of the coefficient of yield of tuyères working with a free flow.—Kyrille **Popoff**: The convergence of series in ballistics.—E. M. **Antoniadi**: Changes recently observed on the planet Jupiter with the 83 cm. telescope of Meudon Observatory. A detailed description of recent changes in the surface of the planet, with two reproductions of photographs.—Léon **Brillouin**: A general type of problems, allowing the separation of the variables in the undulatory mechanics of Schrödinger.—Louis de **Broglie**: Remarks on the new undulatory mechanics.—Lucien **Mallet**: The luminescence of water and organic substances submitted to γ-radiation. Under the influence of the γ-rays, water and certain transparent organic liquids exhibit a marked luminescence. The light from water contains ultra-violet rays of wavelength less than 3000 Å.U.—F. **Wolfers**: A probable action of matter on the quanta of radiation.—Pierre **Auger** and Francis **Perrin**: The distribution in space of the directions of emission of the photo-electrons.—Rodolphe **Berthon**: The projection and reproduction of reticulated photographs.—Pierre **Thomas** and Mlle. Mari **Sibi**: Contribution to the study of the structure of jellies. Organogels obtained with the benzoylacetal of sorbite.—P. **Dumanois** and P. **Laffitte**: The influence of the pressure on the formation of the explosive wave. From experiments ($2H_2+O_2$) with initial pressures from 1 to 6·5 atmospheres, the distance travelled by the flame before the explosive wave is set up diminishes as the pressure increases, at first rapidly and then more slowly.—Michel O. **Samsoen**: The dilatometric and thermal study of glasses composed of silica and soda.—Marcel **Laporte** and Mario A. da **Silva**: The mobility of the negative ions and ionisation currents in pure argon. From the results of earlier work, it was concluded that in perfectly pure argon the saturation current would be obtained with a much lower potential difference than in air: this prediction is now confirmed experimentally. The curves given show that saturation is obtained in highly purified argon at 50 volts, whilst in air, saturation is not reached at 1760 volts. The effect of impurities on the ionisation curve of argon is shown.—Georges **Denigès**: The action of hydrobromic acid and of the alkaline bromides in acetic acid solution on cupric bromide. A new cupric reaction. The reaction is based on the colour produced by the addition of a cupric salt to pure acetic acid containing some potassium bromide.—A. **Travers** and **Malaprade**: The constitution of solutions of molybdic acid. Solutions of molybdic acid contain a condensed acid, $4MoO_3 . H_2O$, which, by analogy with metatungstic acid, may be called metamolybdic acid.—R. **Cornubert** and Ch. **Borrel**: The action of benzaldehyde on cyclanones containing the groups —$CH(CH_3)$. CO . CHR— or —CHR . CO . CH_2—.—G. **Bruhat** and V. **Thomas**: The dimagnesium compounds containing the benzene nucleus. An account of the general reactions of compounds of the type $C_6H_4(MgI)_2$.—G. **Vavon** and **Jakeš**: The catalytic hydrogenation of conjugated double bonds. So far

as concerns the addition of hydrogen by the catalytic method, the presence of a system of conjugated double bonds does not entail any special ease of hydrogenation, and does not permit partial hydrogenation in the 1 : 4 position. From this point of view, there are marked differences between the catalytic and nascent hydrogen methods of reduction.—Marcel **Sommelet**: A mode of preparation of tertiary amino derivatives of tertiary alcohols.—V. **Ipatief** and B. **Dolgof**: The hydrogenation of triphenylcarbinol and of phenylfluorenecarbinol under pressure. The end product of this reaction is tricyclohexylmethane $(C_6H_{11})_3CH$, the analysis and physical properties of which are given. The product previously described under this name by Godchot is shown to have been impure.—L. **Léger** and F. **Blanchet**: The grit formations of the isles of Port-Cros and of the Levant.—E. **Rothé**, J. **Lacoste** and Mme. A. **Hée**: Earthquakes in France in 1925. There were twelve earthquakes in France in 1925, only half the number in the preceding year. Details of the distribution and intensity are given.—Lucien **Mayet**: The fossil men of the Denise: the masculine frontal bone (the Frontal Aymard of the Crozatier Museum) at the Puy, Haute-Loire. A detailed study of this bone shows it to be clearly of the type *Homo sapiens*, and presents archaic characters in the sub-orbital region which are only found to-day in the most primitive existing race, the Australian aborigines.—**Michel-Durand**: The physiological rôle of the tannins.—Antonin **Němec**: A chemical method for determining the phosphoric acid requirements of agricultural soils.—Mme. Anna **Drzewina** and Georges **Bohn**: The influence of carbon dioxide on the sperm of the sea-urchin, as a function of the mass.—Max **Aron**: Experimental facts relating to the harmony of growth in the larvæ of frogs.—Charles **Dhéré** and Elphège **Bois**: The comparative study of the fluorescence of some natural and artificial porphyrins.—**Béguet**: The mechanism of agglutination (as regards *Br. melitensis*).—R. **Boyé**: The comparative action of quinine stovarsolate and chlorhydrate in quartian marsh fever.—F. **Rathery** and Mlle. L. **Levina**: The influence of salts of nickel and cobalt on some diabetic patients. Detailed accounts of the treatment and results with eleven patients.

August 2.—Jean **Perrin** and Mlle. **Choucroun**: The parallelism between the fluorescent power and velocity of reaction. Recent views on the production of fluorescence can be brought into line with the theory of Arrhenius (1889) on the existence of activated molecules. The velocity of destruction of a fluorescent body by a suitable reagent should be proportional to the average duration in the activated state, and consequently the probability of destruction of a given molecule should be greater at small concentrations than at high concentrations. Experimenting with methylene blue, it was found that (provided the *p*H remained constant) there was proportionality between the brightness of the fluorescence and the reaction velocity: changing from concentration 1/200 to concentration 1/1500, the brightness was multiplied by 10·5 and the reaction velocity by 11.—J. F. **Ritt**: Simplification of the method of Liouville in the theory of elementary functions.—**Akimoff**: The application of Fourier-Bessel transcendentals with several variables to the development in trigonometrical series of conditionally periodic functions.—**Mandelbrojt**: The trend of functions represented by Dirichlet's series and the growth of analytical functions round a singular point.—Georges **Alexitch**: The values of an analytical function taken on the circumference of the circle with radius unity.—N. **Podtiaguine**: The order of the growth of functions.—S. A. **Gheorghiu**: The theory of correlation.—Mlle. **St. Maracineanu**: Special actions of the sun on the radioactivity of polonium and lead. The experiments described appear to indicate that the solar radiation can cause the reintegration of radium E starting from radium F (Po), a reversibility in the radioactive series.—Pierre **Vernotte**: A regulator of E.M.F. and of current.—A. **Guillet**: The rectifying contact. A discussion of the theories of the action of the detector in wireless telephony.—A. **Dauvillier**: The telephote, an apparatus for television with the aid of vacuum tubes. Preliminary experimental results.—Eugene **Laborde**, Jean **Bressolles** and Léon **Jaloustre**: The influence of some radioactive elements on the catalytic activity of certain proteo-bismuth precipitates. The catalytic activity of the radioactive proteo-bismuth compounds (towards solutions of hydrogen peroxide) depends on the nature of the radioactive element present and its concentration in the medium in which the precipitate was formed. Barium alone is not without influence. Some possible therapeutic applications are indicated.—Mlle. **Choucroun**: The radio-chemistry of fluorescent bodies. Certain fluorescent organic substances (such as methylene blue) dissolved in a reducing medium are destroyed when exposed to light. Some irregularities in the velocity of this reaction have been traced to the influence of the *p*H of the medium. On adding a buffer solution (sodium acetate) the irregularities are greatly reduced.—A. **Travers** and **Houot**: The thermal study of electrolytic lead. The allotropy of lead. The dilatometric study of highly purified lead gives results consistent with the assumption that there are three allotropic forms of lead.—Robert F. **Le Guyon**: A new general analytical method: volumetric analysis, using a centrifuge. In volumetric precipitation methods of analysis, for which no suitable colour indicator is available, the use of a centrifuge is suggested.—J. **Orcel**: An attempt at the classification of the chlorites. The classification is based directly on the analytical results, using four characteristic ratios: *s*, *f*, *a*, and *c*, where $s = SiO_2/R_2O_3$, $f = FeO/MgO$, $a = Fe_2O_3/Al_2O_3$, and $c = Cr_2O_3/Al_2O_3$.—E. **Passemard**: The alluvial terraces of the Euphrates and the prehistoric implements they contain.—Henry **Hubert**: First observations relating to (electrical) atmospheric parasites in Western Africa.—Mlle. Laura **Kaufman**: The effect of the heterogeneous embryonic juice on the rapidity of emigration of the cells and the first stages of growth of cultures of tissues.—Paul **Camboué**: The prolongation of life in decapitated butterflies.—Baptiste **Roussy**: Unexpected and striking psychic facts manifested by a series of spiders of the genus *Epeire diademe* for keeping their webs in a vertical plane. These spiders attach to a line and lift to a distance from the soil heavy bodies (leaden wire, stones, snails), this serving the purpose of maintaining the web vertical. In one case the weight of the lead was 0·27 grams and the weight of the spider lifting it was 0·05 grams.—F. **Henrijean** and W. **Kopaczewski**: Researches on the composition of the squill and its tonicardiac principle.

August 9.—Jacques **Chapelon**: The minima of quadratic forms.—René **Lagrange**: Legendre functions of the first species and certain associated functions.—S. Piña **de Rubies**: The arc spectrum of europium. Measurements made at the normal pressure, between λ3500 and λ3100.—P. **Budnikoff**: The activation of the inert varieties of calcium sulphate. Natural anhydrite and the calcium sulphate obtained by dead burning gypsum do not set in contact with water, but can acquire this

property if certain catalysts (lime, caustic soda, ferrous sulphate, etc.) are present.—L. **Hackspill** and H. **Pinck**: The displacement of cæsium and rubidium by iron. The method of preparing sodium and potassium described in an earlier communication (heating in a vacuum with metallic iron to a temperature at which the vapour pressure of the alkali metal is of the order of one centimetre or mercury) has now been applied with success to salts of cæsium and rubidium.—F. **Bourion** and E. **Rouyer**: The determination by the boiling point method of the equilibrium constant relating to the formation of the complex compounds formed by mercuric cyanide.—André **Job** and Antoine **Cassal**: The preparation of a chrome-carbonyl by the intermediary of a magnesium compound. By the interaction of carbon monoxide and phenyl-magnesium bromide in ether solution and in presence of chromic chloride a chrome carbonyl is formed which can be isolated in colourless crystals. Analysis proves the compound to be $Cr(CO)_6$.—L. **Semichon** and **Flanzy**: The pectins of grapes and mellowness of wines.—Mme. Eliane **Le Breton** and Charles **Kayser**: The law of size and the respiration of tissues *in vitro* in the homeotherms.—J. **Pelosse**: The Entomostraceæ of the pelagic fauna of Lake Bourget (Savoy).—A. **Paillot**: Silkworm disease (*flacherie*) and its causes.

WASHINGTON, D.C.

National Academy of Sciences (Proc. vol. 12, No. 7, July).—G. H. **Parker**: (1) The inquiline fish Fierasfer at Key West, Florida. Specimens were found in the cloacal cavities of certain holothurians; the sea-cucumbers averaged 25 cm. in length and the fish about 9·5 cm. (2) The growth of turtles. Turtles, like alligators, show great fluctuations in rate of growth, some of them justifying their reputed slow development. Out-of-door conditions seem to speed up growth.—Edwin B. **Wilson** and Carl R. **Doering**: The elder Peirce's. The Peirce family, descendants of John Pers who arrived at Watertown, Mass., in 1637, has contributed three members to the National Academy of Sciences, a mathematician, a logician, and a physicist. A genealogy was published in 1880 and the present deductions are from it.—Edwin J. **Cohn** and James B. **Conant**: The molecular weights of proteins in phenol. Freezing-point determinations are invalidated by traces of impurities and of water. It is difficult to remove the last trace of water. Accordingly powdered anhydrous calcium chloride was added to the phenol solution, and it was found, using substances of known molecular weight, that the freezing-point is unchanged so long as the system contains the solid anhydrous chloride in equilibrium with its hydration products. Determinations with zein give no indication of dissociation into units of low molecular weight in phenol, and suggest that the true molecular weights of proteins in phenol, as in water, are high, as found by other methods.—Gilbert N. **Lewis**: The path of light quanta in an interference field. The objections raised by Tolman and Smith to the author's proposed crucial experiment are stated to be inadequate.—K. L. **Hertel**: Effects of an electric field upon the radiating hydrogen atom. The light from hydrogen canal rays is partially polarised, with the electric vector of the stronger component parallel to the beam. The other component is increased where the rays enter or leave an electric field.—H. D. **Smyth** and C. J. **Brasefield**: The secondary spectrum of hydrogen and the occurrence of H_3^+. Positive ions from a discharge tube are collected by a Faraday cylinder, and graphs can be constructed giving the relative concentrations of H^+, H_2^+, and H_3^+. Simultaneously with the measurements of ionic current, photographs were taken with a constant deviation spectrograph. It is then found that conditions favouring the production of H_3^+ favour the excitation of the Fulcher bands, especially those in the red.—G. W. **Giddings** and G. F. **Rouse**: Ionisation of mercury vapour as a function of the intensity of exciting light. Monochromatic light of wave-length 2536 Å.U. is used, and its intensity varied by fused quartz plates. For low pressures, ionisation varies as the square of the light intensity, suggesting a two-stage cumulative process.—R. C. **Gibbs** and H. E. **White**: Doublets of stripped atoms of the potassium type. The so-called regular and irregular doublet laws are extended to the stripped atoms of scandium, titanium, and vanadium, and the doublets predicted were found.—G. **Breit**: The electromagnetic mass and momentum of a spinning electron. Assuming a rigid surface distribution of charge and that its mass is entirely electromagnetic, the radius of the electron is of the order of 10^{-12} cm.; the peripheral speed may exceed the velocity of light, c, by a factor of 20. For stability and a peripheral speed of the order of c, there is some connexion between h, e, c, and m, showing that, approximately, electric charge is quantised.—F. **Zwicky**: (1) The quantum theory and the behaviour of slow electrons in gases. A formula is given for the deviation from rectilinear motion in the field of force of the atoms. (2) Transfer of energy from electrons to atoms.—G. A. **Miller**: Form of the number of the prime power subgroups of an abelian group.—Carl **Eckart**: The solution of the problem of the simple oscillator by a combination of the Schroedinger and the Lanczos theories. Schroedinger's equation, a quantum condition in the form of a variation principle, gives a set of orthogonal functions, and if these are interpreted as those entering into the Lanczos theory, the matrices of the Born-Jordan theory can be obtained.

Diary of Societies.

SATURDAY, SEPTEMBER 11.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (Eastern District) (at Great Yarmouth), at 11 A.M.

TUESDAY, SEPTEMBER 14.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—J. A. Aiton: Steam Pipes for Super High Pressure.

SATURDAY, SEPTEMBER 18.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (North-Eastern and Yorkshire Districts) (at Whitby), at 12.

PUBLIC LECTURE.

THURSDAY, SEPTEMBER 16.

CORDWAINERS HALL (7 Cannon Street, E.C.4), at 7.30.—H. Bradley: Michael Faraday—A Pioneer of Progress.

CONGRESSES.

SEPTEMBER 12 TO 18.

INTERNATIONAL CONGRESS FOR APPLIED MECHANICS (at Federal Technical University, Zurich).—Lectures by Prof. P. W. Bridgman, Prof. P. Debye, Prof. T. Levi-Civita, Prof. L. Prandtl, and Prof. G. I. Taylor.

SEPTEMBER 13 TO 17.

INTERNATIONAL CONGRESS OF PHILOSOPHY (at Harvard University, Cambridge, Mass.).

SEPTEMBER 14 TO 16.

INSTITUTION OF PUBLIC LIGHTING ENGINEERS (Annual Meeting and Conference) (at Newcastle-upon-Tyne).

September 15, at 9.30 A.M.—R. Davison: Presidential Address.—J. F. Colquhoun: The Improved Lighting of a City.—Major S. Cooke: Motor Traffic in Relation to Lighting (*a*) on the Highway, (*b*) on the Vehicle.

September 16 (Morning).—R. Beveridge: Variations of Hours in Public Street Lighting.—H. Dickinson: Electric Street Lighting in Liverpool.

SEPTEMBER 19 TO 26.

GERMAN SCIENTIFIC AND MEDICAL ASSOCIATION (at Düsseldorf).

SEPTEMBER 22 TO 24.

GERMAN RÖNTGEN SOCIETY (at Düsseldorf).—Discussions on X-ray Treatment of Inflammation, the Compton Effect, and Irradiation of the Ovary and Offspring.

SEPTEMBER 26 TO 29.

INTERNATIONAL CONGRESS OF INDIVIDUAL PSYCHOLOGY (at Düsseldorf).