THURSDAY, JULY 23, 1903.

EXPERIMENTAL MORPHOLOGY.

Willkürliche Entwickelungsänderungen bei Pflanzen. Ein Beitrag zur Physiologie der Entwickelung. By Georg Klebs. Pp. iv + 166. (Jena: G. Fischer, 1903.) Price 4 marks.

THIS is practically a continuation of Dr. Klebs's well-known work "Die Bedingungen der Fortpflanzung bei einigen Algen und Pilzen" (Jena, 1896), but whereas that was concerned with the lower organisms the present work deals with phanerogams. Both works are contributions to experimental morphology, the essential feature in both being the performance of a series of experiments skilfully planned so as to discover the nature of the external conditions which lead to certain definite changes of form or function in plants. Englishmen will be glad to see that to Andrew Knight is given the honour of being the founder of this type of work; then follow Hofmeister, Vöchting, Sachs, Goebel, Bonnier, &c., nor should it be forgotten that Klebs himself has worked steadily and with brilliant effect on this line since 1889.

Klebs's aim is definitely objective; he seeks to discover facts, without regard to whether the changes arising under given conditions are adaptive. He nevertheless allows himself to postulate a certain mechanism in the organism by which he conceives it possible that external conditions produce their effect. His discussion is interesting, but his terminology seems to us open to criticism, nor does his theory strike us as essential to his aim—the foundation of causal morphology in a purely objective sense. He takes, as an instance, the undifferentiated cells in the growing-point of a plant, in which reside the possibility of developing into organs characteristic of the species. The physical substratum in which this potentiality resides he calls "specific structure." This he assumes to be constant, which implies (we imagine) that under certain definite conditions it always develops an identical form, while if the conditions are different the form will be different. Under the heading "conditions" he distinguishes external and internal. He retains the term external as being already in common use, though he seems to prefer the expression "directe oder unmittelbare aüssere Bedingungen." These are the various chemic, thermic, photic, and mechanical influences which act on the organism from its earliest stages. The definition of the inner conditions is as follows:—

"Every phenomenon of life occurs within the organism; it is a consequence of the internal conditions ruling at the moment. The quality and quantity of the substances present in the cell, the various kinds of ferments, the physical properties of the protoplasm, cell-sap, cell-wall, &c., all these belong to the internal conditions,"

and are "in the first instance supplied to the individual by its origin from a previous generation."

He also strongly insists on the internal conditions being completely distinct from the specific structure. We fail to see that a real distinction between internal and external conditions is made good. For instance, a naked protoplast placed in a nutrient fluid—a solution of glycerin—is subjected to new external conditions. But a vegetable cell treated in the same way takes up glycerin into its cell-sap, and by the above definition the physical properties of the cell-sap are internal conditions. Yet in both cases the change consists in exposing protoplasm to a certain solution. Nor again can we clearly distinguish between internal conditions and specific potentiality. In a mechanical theory such as Klebs's the "specific structure" must depend on the physical properties of protoplasm, yet these last named are said to be part of the internal conditions.

All that Klebs proves by his experiments is that a change of external conditions determines a change in the form and physiological processes of the organism. We may conclude from this that the undeveloped tissues are under the rule of changing conditions, but have we a right to draw any other conclusion? Klebs has shown that Saprolegnia grows continuously if supplied with good culture-fluid, but that it at once forms zoosporangia if the culture-fluid is replaced by pure water. The same thing happens if the fungus is left to itself with a limited supply of food, *i.e.* it forms zoosporangia when the nutriment runs short, thus by its own activity it makes the conditions necessary for zoospore formation. Or, what is another way of putting the matter, the artificial exchange of nutrient fluid for pure water induces zoosporangium-formation because it is an imitation of the natural series of changes to which the plant is subject. Klebs does not pretend to say how pure water leads to zoosporangia being formed; he shows it to be a necessary condition, but the causal connection is absolutely unknown. It possibly always will be so, but it is at least possible to give the problem its proper place among cognate questions, *i.e.* those relating to reflexes. These are most conveniently studied in the facts of movement, but there is no reason for excluding the facts of experimental morphology. In our opinion, the purely objective method applied to reflexes is incomplete; we differ markedly from Klebs in thinking it impossible to deal fully with the question without taking adaptiveness into account. The fact that a stem bends upwards when deflected from the vertical, depends on some strain or pressure produced in the protoplasm by such deflection. We call this a stimulus, but only because it precedes the act of curving and by endless repetition is associated with that act. What was originally a physical concomitant of a certain position of the plant in relation to the vertical comes to be a stimulus. It may be said that the primeval plant which acquired geotropism did so because there is some unknown but necessary connection between mechanical strain applied to protoplasm and the act of curving upwards. But if so why are essentially similar plants stimulated to downward curvature by a like strain? Only a vague answer can be made from the objective point of view. From the adaptive point of view there is no difficulty; any curvature may become associated with any physical change in the protoplasm, upon which it normally and continuously follows. The importance of natural selection is here obvious, for it picks out the plants which have the capacity of association, and which, to speak metaphorically, are able to use changed conditions as signals for serviceable movements. Without selection we cannot conceive the forging of the chain of inherited habit which binds plants to the performance of adaptive movements.

It is true that we cannot say in what the association consists, and it will doubtless be said that our point of view only differs from that of Klebs in substituting "stimulus" for "conditions." The difference is essential, for we take into account natural selection as a universal condition under which all organisms subsist.

We must be content to differ from Dr. Klebs, who goes so far as to say (p. 162) that the adaptation (Zweckmässigkeit) of organisms is in no way (gar nicht) a scientific problem. We are none the less ready to welcome his researches, of which we proceed to give some account.

Among the results obtained by Klebs some of the most interesting are the experiments in which, by appropriate culture conditions, he converts an inflorescence into an ordinary vegetative shoot. For instance, by making a cutting of the flowering shoot of *Veronica chamaedrys* and growing the plants in damp air, he converts an organ of limited growth into one of unlimited growth, with leaves differing in size, character of hair and phyllotaxy from those of the inflorescence, and resembling the ordinary vegetative shoot.

Another interesting series of observations is on *Glechoma hederacea*, which, if grown in a greenhouse and watered with nutritive solution, never flowers, whereas parts of the same individual plant, grown in small pots in summer and kept cool in winter, flower in the following summer. By special treatment he even compelled flowers to appear on the runners, whereas normally only the upright shoots bear flowers. *Ajuga reptans* bears runners in the axils of its rosette-leaves; these form in the autumn new terminal rosettes, the central shoots of which flower in the following spring. This is the normal state of things, but Klebs converted a flowering shoot into a runner by darkness and damp heat, and also produced other curious anomalies of development. In another experiment on the same type he introduced a runner into the lower end of a cylinder of water, when its normally horizontal growth was changed and it grew straight up until it reached the air, where it once more became horizontal. Klebs devotes a section of his book to a discussion of the facts of regeneration for which we are largely indebted to Vöchting. Klebs points out that we do not even know why the severance of a part from its parent should lead to a regenerative outgrowth of roots and shoots; he goes on to demonstrate by experiments that in *Salix vitellina* a branch, without being severed from its parent, can be forced to make roots by submergence in water. He uses this fact as an argument against the adaptive explanation of the behaviour of cuttings. It proves, of course, that some of the phenomena are producible without severance, but the facts of severance remain; two different stimuli may produce the same result, as in the well-known experiment of Pfeffer in which the root-hairs of the gemmæ of Marchantia develop on the physically lower side and also on the side in contact with a solid body.

Another section of the book deals with the length of life of plants and the cognate facts on resting periods in vegetable growth. He shows that Parietaria can be kept in constant flower for two years. That in annuals there is no inherent limit to their development, as he proved by making a series of cuttings of the growing shoots. Again, he compelled the winter buds of Gratiola to germinate (contrary to their habit) without a resting period, by cultivating the plant under water and placing it in a greenhouse in autumn. These may serve as examples of the experimental work in which Dr. Klebs is engaged. It is evidently a research which tests to the full his ingenuity and determination, and it is one in which all naturalists will wish him the success he deserves.

The book concludes with a section on "Variation and Mutation," which will be useful to old-fashioned evolutionists in showing the trend of certain younger schools of thought. FRANCIS DARWIN.

NITROGEN AND ITS COMPOUNDS.

Der Stickstoff und seine wichtigsten Verbindungen. By Dr. Leopold Spiegel. Pp. xii+912. (Braunschweig: Vieweg und Sohn, 1903.) Price 20 marks.

THE large and ever-increasing amount of work turned out by research chemists in all branches and departments of the science, and the dispersal of the results of investigations throughout a sufficiently extended array of publishing media, awaken the demand for some means by which the wealth of newly-acquired knowledge may be made easily accessible; and the editor or author who undertakes the very tedious but important task of collecting from the different sources and arranging in a summarised form all, or even the most important, facts which have been established, performs a service to his science for which he does not always receive due credit.

The importance of the compounds of nitrogen for the study of valency and the formation of complex compounds, the important position which they occupy in investigations into the laws of stereochemistry, and, in the case of the carbon compounds, the determining influence of the nitrogen atom on the character of the molecule, have led the author to the compilation of a volume which brings together all the most important known facts with regard to the chemical and physicochemical relationships of this element and its compounds. No separation is made of the organic from the inorganic compounds, but the latter are treated much more fully than the former. With regard to the organic compounds of nitrogen, the author has wisely refrained from a duplication of "Beilstein," and has contented himself with pointing out the more important characteristics, and with giving in tabular form the chief representatives of the different groups.

The whole matter is arranged under the following headings:—the element, halogen compounds of nitrogen, oxygen compounds of nitrogen, sulphur compounds of nitrogen, hydrogen compounds of nitrogen, metal nitrides, phosphorus compounds of nitrogen, arsenic nitride, carbon compounds of nitrogen, silicon nitride, titanium compounds of nitrogen, zirconium nitride, boron compounds of nitrogen, nitrogen in closed rings, alkaloids, protein substances, analytical methods, addenda.

The treatment of the element and its important inorganic compounds, *e.g.* nitric acid and ammonia, seems very satisfactory, although, for instance, the action of hypobromite on ammonium chloride might well have been included in the list of methods of preparing nitrogen, instead of merely being referred to incidentally in another connection.

Apparently no attempt has been made to sift critically the large accumulation of material at the author's disposal, and the book therefore assumes the character of a dictionary. Nevertheless, several cases are to be found where a more connected treatment is given to the subject, as, *e.g.* in the description of the steps by which the formation of nitric acid in the soil was traced to a specific ferment, or in the account of the application of Werner's theories to the constitution of the metal ammonia compounds. Such accounts, although written in briefest outline, serve to direct attention to points of importance in theoretical chemistry. The account of the diazo-compounds one could wish fuller, and some reference might have been expected to Goldschmidt's important work on the dynamics of the diazo- and azo-compounds. In mentioning the transformation of ammonium thiocyanate (the melting point of which is 149°, not 159°) into thio-urea, also, the work of Waddell might have been referred to. Further, in the analytical portion of the book, although various methods are given for the estimation of nitrogen in organic compounds, no mention is made of the Frankland-Armstrong modification of Dumas's method, although it is probably the most convenient and accurate method of estimation.

In compiling the book, the chemical literature up to 1900 has been taken into account; and in an appendix additions and corrections are given bringing the work up to 1902. In spite of some omissions, the book will be readily welcomed as an important addition to the works of reference in chemistry, and the author deserves the thanks of his fellow-workers for the trouble he has taken in the compilation.

A. F.

PROSPECTING.

La Prospection des Mines et leur Mise en valeur. By Maurice Lecomte-Denis. Pp. xv+551, with 320 figures. (Paris: Schleicher, 1903.)

WHEN an author is fortunate enough to have such a godfather for his book as M. Haton de la Goupillière, it may be taken for granted that the work contains much useful matter. The book is intended not so much for the old-time prospector, armed with pick, shovel, and pan, who wanders about in search of gold, as for the scientific mining engineer called upon to report upon a mineral deposit already discovered, and possibly already worked on a small scale. M. Lecomte-Denis tells the novice how to set about his work, and how to draw up his report to his employers, and he points out useful precautions to be observed in purchasing mines and minerals. The motto for the chapter upon "salting," "*Défiance est mère de sûreté,*" is well chosen; many of the common tricks of fraudulent mine-vendors are exposed by the author, who most wisely advises the inspecting engineer to err on the side of scepticism when making his examinations.

Next come two purely geological chapters upon the distinctive characters of the igneous and of the sedimentary rocks. It is doubtful whether it is wise to burden a book upon prospecting with more than three hundred figures of fossils. M. Lecomte-Denis points out, however, that the traveller cannot carry a geological library with him, and that it will probably be a convenience to him to possess a little palæontological information for immediate reference on the spot.

Six chapters are devoted to the study of the modes of occurrence of the most important useful minerals, viz., coal, petroleum, bitumen, and the ores of iron, copper, zinc, and lead. Many useful commercial data are appended. Similar information concerning phosphates, bauxite, and the ores of tin, mercury, &c., is promised in a later edition.

When a mineral deposit has been found, it is usually necessary to investigate its commercial value by certain preliminary workings. The manner of carrying these out and of making deductions from the results obtained is treated in a long and useful chapter. The author speaks wisely with regard to writing reports when he bids the engineer weigh his words very carefully, for extracts may be made, and words may be twisted, so as to convey a meaning very different from that which was intended. The greatest prudence is necessary on the part of inspecting engineers with the object of not raising his employer's hopes too high, nor, on the other hand, by an unnecessarily pessimistic tone, of preventing him from embarking upon an undertaking which may have many chances of success. What is required is complete frankness; let the capitalist know the grounds upon which the engineer bases his opinions. If the former is in doubt, he can then go to a consulting mining engineer and say, "Supposing these data to be true, what is your advice?"

The inspecting engineer should certainly make himself acquainted with the mining laws of the country in which the property upon which he is reporting is situated; and the brief remarks of M. Lecomte-Denis upon foreign mining jurisprudence may serve as a first step in the study. On the other hand, more space is devoted to an exposition of the mining laws of France than seems to be necessary.

The tables at the end of the book are similar to those found in the usual miners' pocket-books. Some palpable errors show that sufficient care was not taken in preparing them for the press, and consequently the reader may feel a little sceptical about their trustworthiness. On the whole the book is likely to prove useful to the mining engineer, for it deals with matters which are usually considered somewhat outside the scope of the ordinary text-books.

OUR BOOK SHELF.

The Revival of Phrenology. The Mental Functions of the Brain. By Bernard Hollander, M.D., &c. Pp. xviii + 512; illustrated. (London: Grant Richards. 1901.) Price 21s. net.

According to Dr. Hollander, the connection between mind and brain has long been waiting for a discoverer, and he is determined that it shall wait no longer. "The present work aims at clearing up the mystery of the fundamental psychical functions and their localisation in the brain. It is the first work on the subject since the dawn of modern scientific research." We expect that an author who claims to clear up a mystery and to write the first work on a subject since the dawn of scientific research should at least be acquainted with the present position of the science with which he deals, but we do not find that Dr. Hollander has satisfied this preliminary requirement. The very title of his book indicates that he is not before, but behind the age. Mental phenomena are not functions of the brain in the modern medical meaning of the term "function," and if by "the fundamental psychical functions" Dr. Hollander means the primary divisions of mind as recognised in modern psychology, then we cannot find evidence in his book that he knows what they are. "Most men," he says, "regard mind as though the term were equivalent to intellect and did not include the feelings and fundamental impulses." "The great majority hold mind to be equivalent to intellect." We do not know whether by "most men" and "the great majority" Dr. Hollander means the majority of the whole population, or of the whole male population, or of neurologists, or of psychologists. If he means either of the two former, he is probably wrong. If he means either of the two latter, he is certainly wrong; so wrong that it is difficult to believe that he has opened a book on psychology that has been published within the last half-century. When a writer presumes to lecture the whole world of psychologists in the tone of the Supreme Being addressing a group of blackbeetles, he should at least make himself acquainted with the rudiments of their terminology. He would then avoid speaking of "faculties" as "forces." He would not say that "satisfaction, discontent, desire, fear, anger . . . &c., are so many states of our internal organisation which . . . exist . . . without consciousness . . . being necessary."

"The data amassed by the author," Dr. Hollander modestly asserts, "are so considerable as to open up quite a new field for research." These data consist of more than 800 cases, which are alleged to illustrate the connection between some special brain-area and some special phase of mind. The first group are "cases of melancholia due to injury to the central parietal area." A number of cases of injury to the parietal region are adduced, but in many of them there is little or no evidence of melancholia. Whenever, in the reports, the word depression is used, Dr. Hollander accepts it as the equivalent of melancholia, though it is quite obvious that in many cases it means hebetude, stupor or coma. Melancholia is attributed to blows on the parietal region that were inflicted four years, five years, six years, fourteen years, seventeen years before the patient came under treatment. Of the innumerable multitudes of cases of lesion of the parietal region without any sign of melancholia resulting, not a word is said. This is not scientific investigation; it is special pleading. Dr. Hollander pleads that in view of the important bearing of his facts upon the entire development of medical science, on the study and treatment of lunacy, on the education of the young, &c., the evidence and statements may be received willingly and in fair spirit, however critical. We have endeavoured to comply with his request. We have weighed his evidence, and it seems to be of the same value as his statements.

St. Kilda and its Birds. By J. Wiglesworth. Pp. 69; illustrated. (Liverpool: C. Tinling and Co., 1903.)

On his return from an ornithological trip to the St. Kilda group last summer, Dr. Wiglesworth delivered before the Liverpool Biological Society a lecture on these islands and their inhabitants—human and otherwise. This lecture has been published in the volume before us, and although the author has little or nothing absolutely new to tell, he has undoubtedly succeeded in producing a very interesting work, which ought to be invaluable to all future tourists in these islands. Although the extension of the breeding range of the fulmar-petrel to the Shetlands has deprived St. Kilda of one of its claims to preeminence, yet it possesses an absolutely peculiar form of wren as well as two mice of its own, while it is also one of the chief breeding-places of the fork-tailed petrel. Moreover, its breeding-list of other sea-birds is comparatively large, so that the island possesses especial interest for the ornithologist and egg-collector. Unfortunately, the latter individual has of late years made himself somewhat too conspicuous, and "when it comes to dealers giving unlimited orders for fork-tailed petrels' eggs at prices which set the whole male population of the island on the alert to dig out every petrel-burrow they can possibly come across, one cannot but feel considerable anxiety as to the future of this interesting species." High prices are likewise paid for the eggs of the St. Kilda wren, of which large numbers are exported. It would therefore seem that the island stands in urgent need of the special attention of those interested in bird preservation. One of the features of St. Kilda is the number of species of petrels by which it is inhabited, while not less noteworthy are the hordes of puffins which swarm over its grassy slopes, and tenant almost every available nook amongst the rocks and boulders.

But it is not only for its birds and mice that the St. Kilda group has a special claim on the interest of the naturalist. One of the islets, Soa, or Soay, is remarkable as being the only locality in Great Britain where sheep exist in a wild condition. It appears that in the latter part of the eighteenth century the owner of St. Kilda laid claim to one out of every seven sheep born in the main island. These sheep were carried to Soa, where, in the absence of anyone to look after them, they ran completely wild. And by this accident has been preserved to our own time the very small and peculiar breed of sheep which was probably once common to St. Kilda and most of the western islands, but has everywhere, except in Soa, been modified by the introduction of other breeds. Most of these sheep are light brown in colour, although a few are almost black, and others nearly white. They are so wild and shy that they cannot be approached within 100 yards, except by careful stalking, while their activity and speed are such that they cannot be hunted down by the dogs of the islanders. A ewe of this sheep, as well as the skull of a ram, are exhibited in the Natural History Museum. R. L.

The Principal Species of Wood. By C. H. Snow, C.E., Sc.D. Pp. xi + 203. (New York: Wiley and Sons; London: Chapman and Hall, Ltd., 1903.) Price 15s. net.

In producing this work the author has evidently spared himself no pains to collect a vast amount of statistics concerning the genera and species with which he deals. The work is also profusely illustrated by plates, and these, along with the general equipment of the book, reflect credit on artist and publishers. Tabulated statements concerning the different species are given, and contain data such as modulus of elasticity and rupture of wood, as well as notes on its various structural qualities and representative uses. These will prove of value to both expert and amateur.

From its title one might be led to suppose that the book was an addition to the literature of strict forest botany, but the preface states that "It is intended for those who are not foresters or botanists, but who use woods or desire a knowledge of their distinguishing properties." The preface further states that "Although great care has been taken to check each fact, errors no doubt exist, although it is not believed that there are important ones." We cannot entirely agree with the author in this. For example, in the introduction we are told that a true wood fibre originates from several cells, "a resin duct is a cell structure or a fibre," "a vessel is a short wide tube joined vertically end to end with others of its kind."

Inaccuracy and vagueness of expression are to be found elsewhere in the book. For instance, "Europeans regard the Ash for ornamental purposes, but Americans value it for wood" is an error that may perhaps be excused in an American writer, but why should the leaves of Eucalyptus be described thus?—"Those of young blue gums are bright blue, oval and stalkless, while leaves of older trees have stems (*sic*), are dark green and sickle-shaped."

Attention is further directed in the preface to the fact that "Allusions to trees, historical and other references, aside from those directly regarding woods, are made for completeness and in order to mark, distinguish, or separate the species." The author fails to realise this object. The distinguishing characters given are far too vague and general to be of any practical value.

On the whole the book contains much useful information and statistics regarding the various species of wood, both broad-leaved and coniferous. It would have been much better, however, had the author confined himself to the treatment of this aspect of the subject alone, leaving out all botanical and other technical matter.

Lehrbuch der Mikrophotographie. By Dr. Carl Kaiserling. Pp. viii + 179. (Berlin: Gustav Schmidt, n.d.) Price 4 marks.

ALTHOUGH there are several well-known treatises on this subject, it is doubtful whether any exceed in thoroughness the one now under notice. The essential conditions for the production of photomicrographs of the highest class are carefully described, and each part of the process is treated fully.

There is no more important point than the illumination of the object itself, and both the source of light and its colour should be selected to bring out the desired points in the resulting photographs.

This part of the subject is generally treated all too briefly, but in the present instance its importance is evidently recognised. The various ways of making light filters and their use with coloured preparations are described. The method of arriving at the proper filter to use with a given preparation is stated to be by determining the absorption spectrum of the dye used for staining, by aid of a hand spectroscope, and then adapting the light filter to give the result desired. This is undoubtedly the only scientific method of using colour screens in photomicrography, and one which we have adopted with success for some time past.

The various types of apparatus by the leading makers are fully described, prominence being naturally given to continental firms. Instructions as to the use of substage apparatus, methods of centring, choice of objectives, and the combination of microscope and camera are included, while it is satisfactory to note that no space is unnecessarily wasted over purely photographic processes. Altogether the book may be recommended to photomicrographers as one of the best yet published. J. E. B.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Source of Radium Energy.

THE novel and unforeseen property of radium of producing energy, which purely kinetic theories, in opposition to the notion of inherent force as a transcendental element, do not seem able to explain, is perhaps destined to give a fresh impetus to discussion from the two distinct points of view. It is meanwhile to be noted with regard to this, that the notion of force acting at a distance from point to point, being equal and reciprocal between the various material points, does not appear to be any better met by the manifestation of the unfailing energy of radium than the simple movements of the kinetic theory. This remark justifies attention being directed to a view of the natural physical forces presented by the present writer more than ten years ago (see Lagrange's "Study of the System of Physical Forces," forming vol. xlviii. of the *Memoirs* of the Royal Academy of Sciences of Belgium). It is there shown that forces exist of such a nature that static equilibrium is impossible, on the impact of bodies of different composition, at their surfaces of contact. They are forces making a body, after the example of radium, emit rays unceasingly without apparent loss of substance. A force of repulsion is referred to here, emanating from the surface, and not from the centre of the mass of atoms, acting on opposed surfaces, and the varying intensity of which is nothing else than what is known to science as absolute temperature. That repulsive force, acting in the inverse ratio of the volume of matter (or of the cube of the distance), just as Newtonian gravitation acts in the inverse ratio of the surface (or as the square of the distance), takes its immediate development, and to some extent visible shape, in Mariotte's law of the relation of pressure to volume in gases. The memoir establishes the existence of a continuous interatomic medium of transcendental qualities not yet understood, conveying the effect of a force acting at the surface of atoms, and the real seat of luminous and electromagnetic wave motion, according to the views to which clearly Lord Kelvin has of late returned. The view now presented is entirely deduced from analysis of the actual facts, worked out at length, and justified by the memoir, and new so far as the case of the impossibility of an equilibrium due to the surface force of repulsion, which gives rise to an exhaustless emission of energy. The reflecting attention of physicists may therefore be legitimately directed to the subject, because it seems certain that the new properties which radium manifests are not explainable by the kinetic hypothesis, but, on the contrary, are of a nature henceforward to modify considerably the speculations of modern physics.

Brussels, July 14. CH. LAGRANGE.

A New Case of Phosphorescence induced by Radium Bromide.

IT is known that salt (NaCl) at a temperature of 200° C. is phosphorescent (*vide* Phipson on "Phosphorescence," p. 20); during a course of experiments in June last I found that radium bromide induces phosphorescence at ordinary temperatures. The following is a convenient way of observing the phenomenon. Fill a wooden match-box with table salt removed from the inner portion of a block; press the radium bromide tube into the yielding mass and just barely cover it with the substance. If it be now put on one side for a few hours, say into one of the compartments of a chest of drawers, on opening the box in the dark all round the tube will be found to phosphoresce with a white light, but, unlike zinc blende and barium platinocyanide, the salt continues visibly to phosphoresce after removal of the radium bromide. The portions of salt round the tube are turned of a faint buff or ochrey tint. The image of the visible portion round and where the radium bromide tube has lain is impressed on a photographic plate in thirty minutes, but only very faintly in two or three minutes. I have tried samples of salt from several localities with the same results. WILLIAM ACKROYD.

Tables of Four-figure Logarithms.

I AM much interested by the short letter, contributed by Prof. Perry to NATURE of July 2 (p. 199), on the subject of four-figure logarithms, especially as I have myself offered a solution of the difficulty which Mr. Harrison has essayed to remedy. If, instead of using Bottomley's differences for the upper part of the tables, viz. from 1000 to 1799, we resort to the usual tabular differences found in any ordinary logarithmic tables, such as Chambers's, we get an even greater accuracy than does Mr. Harrison. The tables are naturally weakest when we have a "9" for the fourth figure of the number the logarithm of which is required. Taking this as a test, between 1000 and 1799 the accuracy of the three methods may be expressed thus :—

	Per cent.
Bottomley's differences	37·5
Ditto, Harrison's extension	58·5
Ordinary tabular differences	76

Tabular differences would be required corresponding to logarithmic differences of 43 to 24 inclusive, *i.e.* twenty small columns of differences. It may be objected that it would be unwieldy in use to change from one method of procedure to another, but I think it will be found, also, that Mr. Harrison's tables are not so easy to use as the unmodified ones. The tabular differences might, indeed, be printed down the side of Bottomley's table without disturbing the usual differences, and only be used when the best possible accuracy is desired.

One of the best solutions of the difficulty has been suggested to me by Prof. Perry himself, viz. divide the number, less than 2000, the logarithm of which is wanted, by 2, and add together the logarithms of quotient and divisor. The approximation to the true logarithm of the number is very good.

I cannot agree that chemists, in any case, should use four-figure logarithms, seeing that they habitually return four figures as significant. I hope, before long, to be able to show that practicable five-figure tables can be constructed to which the reproach of "size" will be inapplicable.

July 3. M. WHITE STEVENS.

PROF. PERRY in NATURE of July 2 (p. 198) gives an illustration of a method whereby the logarithms of the numbers from 1000 to 2000 may be got from a four-place logarithm table with an error of, at most, one unit in the last place.

It is, however, somewhat difficult to see what advantage this arrangement has over the one where the logarithms of the numbers 1000 to 2000 are given (again) after 999 *in extenso* without proportional parts.

By this latter system the tables are certainly increased in size by another double page, but, on the other hand, there is a decided disadvantage in using the relatively large proportional parts for the numbers 1000 to 2000. If the addition of the proportional parts is done on paper, time will be lost; if the addition is done mentally, mistakes may easily occur. C. E. F.

Edinburgh, July 4.

IN mathematical tables the last figure in any tabulated number or difference must be liable to an error $\pm\frac{1}{2}$. When a number is extracted from the tables by aid of a tabulated difference, the result is subject to a duplication of error, that is, to an error ± 1. It will be found on examination that in some of the early numbers of the ordinary four-figure log tables the error is often double this amount. Mr. Harrison's alteration remedies this mistake, and makes the maximum error uniform throughout. The scheme proposed by Mr. Stevens can do no more than this, and would be more clumsy. The figures given by him apparently refer to averages, and are irrelevant.

If the proposal of C.E.F. were adopted, the first portion of the table would have double the accuracy of the remainder; the result of any general calculation would depend on the accuracy of the latter, and little, if anything, would be gained in return for the fact that the space occupied by the tables would be doubled. JOHN PERRY.

A Multiple Lightning Flash.

I HAVE had the privilege of examining the print of the lightning flash taken by Mr. C. H. Hawkins, of Croydon, and referred to in NATURE (July 16, p. 247) by Dr. W. N. Shaw.

The main flash consists really of *three* flashes, the several paths of which are not quite coincident. If a moving camera had been employed (I assume the camera in this case was fixed), then I think the three flashes would have been easily distinguished. The flash on the right is evidently a ramification of the main stream. Except for the above, the photograph shows no other special features.

WILLIAM J. S. LOCKYER.

Solar Physics Observatory, July 17.

The Lyrids, 1903.

THE return of the Lyrids this year was well observed here. Watching was begun on April 15, and continued until April 24, the series being broken only once, namely on April 20, when the sky was overcast. The weather was very favourable, the heavens on most nights being beautifully clear. Eighty-four meteors were registered, of which twenty were Lyrids.

The chief points with regard to the Lyrids brought out by the observations are :—

(1) The display was of moderate strength.

(2) The maximum occurred on April 21 and 22, probably more precisely at midnight on the latter date.

(3) The decrease in activity was more rapid than the rise to maximum.

(4) The radiant on the nights of April 21–22 was at $271\frac{1}{2}^\circ + 33^\circ$ (12 paths).

(5) The colours of the Lyrids were almost wholly of two shades, white and a peculiar yellowish, dirty-looking green.

(6) The meteors were swift, their average angular velocity being 20° a second, not taking into account those which appeared close to the radiant. The real speed of a Lyrid fireball recorded on April 22 by Prof. Herschel at Slough and the writer at Leicester has been computed to have been 39 miles per second.

(7) Only the very brightest Lyrids left streaks.

The first meteor of the shower was observed on April 17. There was a remarkable break on April 19, when not a single Lyrid was seen in a watch lasting three hours, though the seeing was excellent.

Minor Showers.

Besides the Lyrids, radiants were found for the chief active showers as under :—

Radiant-point	Duration	No. of meteors	Remarks
$330^\circ + 35^\circ$ ...	March 29–April 24 ...	4 ...	Slowish; radiant well defined.
216 −26 ...	April 11–24 ...	5 ...	Rather swift, bright, long. Exhibited great variety of colour.
$236\frac{1}{2}+51\frac{1}{2}$...	April 19 ...	4 ...	Short; rather swift. Radiant sharply defined.
$256\frac{1}{2}+37$ ...	April 19–22 ...	6 ...	Swift. Maximum April 22 (5 meteors).

The shower from 216°–26° is very interesting, inasmuch as nothing seems to have been seen of it previous to 1900, in which year it was very active at the Lyrid epoch from 218°–31°. It appears, therefore, to furnish quite a strong display at this period.

A recent writer has calculated that the maximum of the Lyrid shower would fall this year at April 19, 10h. 30m. My observations entirely negative this conclusion, for that night was marked by the complete absence of Lyrids, though the seeing conditions were extremely favourable. The time of maximum actually found was in accordance with that which had previously been inferred. Since in the last few years the maximum has taken place on the 20–21, it was to be expected that, after the omission of leap year in 1900, the epoch would be thrown one day later. ALPHONSO KING.

Leicester, July 11.

THE WILD HORSE.[1]

IN the time of Pallas and Pennant, as in the days of Oppian and Pliny, it was commonly believed that true wild horses were to be met with, not only in Central Asia, but also in Europe and Africa. But ere the middle of the nineteenth century was reached, naturalists were beginning to question the existence of genuine wild horses; and somewhat later, the conclusion was arrived at that the horse had long "ceased to exist in a state of nature."[2]

This view had barely been accepted by zoologists when it was announced from St. Petersburg that a true wild horse had at last been discovered in Central Asia by the celebrated Russian traveller, Przewalsky.

An account of this horse was communicated by Poliakoff, in 1881, to the Imperial Russian Geographical Society.[3] The material at Poliakoff's disposal being limited, zoologists were not at once disposed to admit that Przewalsky's horse, as it came to be called, deserved to rank as a distinct species. Some believed the new horse had no more claim for a place amongst wild forms than the mustangs of the western prairies or the brumbies of the Australian bush; while others asserted it was merely a hybrid between the Kiang (*Equus hemionus*) and a Mongolian or other eastern pony.

Even after the brothers Grijimailo, in 1890,[4] added somewhat to Poliakoff's original description from material (four skins and a skeleton) brought from the Dzungaria desert, naturalists were still sceptical. The greatest English authority on the structure and classification of the Equidæ during the latter part of the nineteenth century was the late Sir William Flower. Writing in 1891, Flower says:—"Much interest, not yet thoroughly satisfied, has been excited among zoologists" by Poliakoff's announcement, but, he added, "Until more specimens are obtained, it is difficult to form a definite opinion as to the validity of the species, or to resist the suspicion that it may not be an accidental hybrid between the Kiang and the horse."[5]

Since Flower expressed this opinion, quite a number of specimens illustrating the form and structure of Przewalsky's horse at various ages have been added to the St. Petersburg Zoological Museum, and in 1902 Mr. Hagenbeck, of Hamburg (commissioned by His Grace the Duke of Bedford) imported from Mongolia between twenty and thirty living Przewalsky "colts." Though about half of these colts found their way to England, and though Dr. W. Salensky, director of the Zoological Museum of St. Petersburg, published last year an elaborate monograph[6] on Przewalsky's horse, English zoologists are not yet satisfied that we have in this member of the horse family a true and valid species.

So far as I can gather, it is generally believed in England that Przewalsky's horse is a hybrid—a cross between a pony and a Kiang. Beddard, however, admits it may be a distinct type. He says:—"This animal has been believed to be a mule between the wild ass and a feral horse; but if a distinct form—and probability seems to urge that view—it is interesting as breaking down the distinctions between horses and asses."[1]

It must be admitted that in its mane and tail Przewalsky's horse is strongly suggestive of a hybrid, but in the short mane and mule-like tail we may very well have a persistence of ancestral characters—in the wild asses and zebras the mane is always short, and they never have long persistent hairs at the proximal end of the tail.

Though a superficial examination may lead one to think with Flower that Przewalsky's horse is an accidental hybrid, a careful study of the soft parts and skeleton inevitably leads to quite a different conclusion. Though failing to understand why so many zoologists persisted in considering the horse of the Great Gobi Desert to be a mule, I decided to breed a number of Kiang-horse hybrids.[2]

Adderley.

FIG. 1.—Kiang pony Hybrid, *æt.* two days.

With the help of Lord Arthur Cecil, I succeeded early in 1902 in securing a male wild Asiatic ass and a couple of Mongolian pony mares—one a yellow-dun, the other a chestnut. "Jacob," the wild ass, was mated with the dun Mongol mare, with a brownish-yellow Exmoor pony, and with a bay Shetland-Welsh pony. The chestnut Mongol pony was put to a light grey Connemara stallion. Of the four mares referred to, three have already (June) foaled, viz. the Exmoor and the two Mongolian ponies. The Exmoor having foaled first, her hybrid may be first considered.

[1] The Wild Horse (*Equus przewalskii*, Poliakoff). By Prof. J. C. Ewart, F.R.S. Read before the Royal Society of Edinburgh, June 15.

[2] Bell's "British Quadrupeds."

[3] A translation of Poliakoff's paper will be found in the *Anna's and Magazine of Natural History*, 1881. See also Tegetmeier and Sutherland's "Horses, Asses and Zebras."

[4] See *Proceedings* of the Roy. Geog. Soc., April, 1891.

[5] Flower, "The Horse," pp. 78, 79.

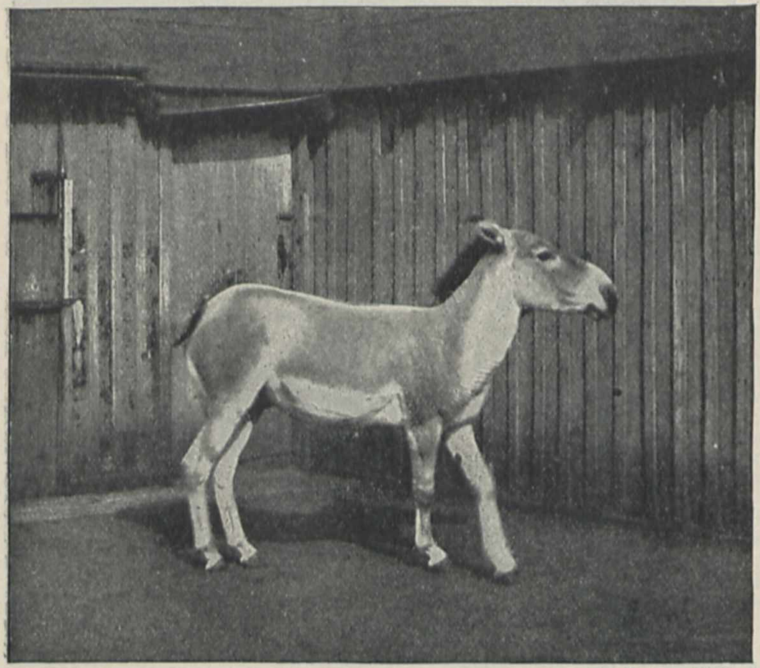
[6] "Wissenschaftliche Resultate der von N. M. Przewal-ki nach Central Asien." Zool. Theil: Band i., Mammalia; Abth. 2, Ungulata. (St. Petersburg, 1902.)

[1] Beddard, "Mammalia," p. 240. (Macmillan, 1902.)

[2] Sir William Flower, the late president of the London Zoological Society, having more than hinted in 1891 that Przewalsky's horse was a mule, one would have thought an effort would have been made forthwith to test this view in the Society's Garden.

It may be mentioned that the Exmoor pony had, in 1900, and again in 1901, a zebra hybrid, the sire being the Burchell zebra "Matopo," used in my telegony experiments. In the case of her Kiang hybrid the period of gestation was 335 days (one day short of what is regarded as the normal time), but she carried her 1900 zebra hybrid 357 days, three weeks beyond the normal time. The Exmoor-zebra hybrids are as nearly as possible intermediate between a zebra and a pony; the Kiang hybrid, on the other hand, might almost pass for a pure-bred wild ass.[1] In zebra hybrids the ground colour has invariably been darker than in the zebra parent; but the Kiang hybrid is decidedly lighter in colour than her wild sire, while in make she strongly suggests an Onager—the wild ass so often associated with the Runn of Cutch. Alike in make and colour, the Kiang hybrid differs from a young Przewalsky foal.[2]

I have never seen a new-born wild horse, but if one may judge from the conformation of the hocks, from the coarse legs, big joints, and large heads of the yearlings—from their close resemblance to dwarf cart-horse foals—it may be assumed they are neither characterised by unusual agility nor fleetness. The Kiang hybrid, on the other hand, looks as if built for speed, and almost from the moment of its birth it has, by its energy and vivacity, been a source of considerable anxiety to its by no means placid Exmoor dam. When four days old it walked more than twenty miles; on the fifth day, instead of resting, it was unusually active, as if anxious to make up for the forced idleness of the previous evening. In the hybrid the joints are small, and the legs are long and slender and covered with short close-lying hair. In the wild horse the joints are large, and the "bone" is round as in heavy horses.



E. Darwin-Wilmot.

FIG. 2.—Sire of Hybrid.

As to its colour, it may be especially mentioned that the hybrid has more white around the eyes than the wild horse, but is of a darker tint along the back and sides and over the hind quarters. Too much importance, however, should not be attached to differences in colour, for, though the two hybrid foals which have already arrived closely agree in their coloration, subsequent foals may differ considerably, and it is well known that young wild horses from the western portions of the Great Altai Mountains differ in tint from those found further east.

Of more importance than the coat-colour is the nature of the hair. A Przewalsky foal has a woolly coat not unlike that of an Iceland foal. In the hybrid, the hair is short and fine, and only slightly wavy over the hind quarters. It thus differs but little from a thoroughbred or Arab foal.

The mane and tail of the hybrid are exactly what one would expect in a mule; the dorsal band, 75mm. wide over the croup in the sire, has in the hybrid a nearly uniform width of 12mm. from its origin at the withers until it loses itself half-way down the tail. The tail, which differs but little from that of a pony foal, is of a lighter brown colour than the short upright mane, while the dorsal band is of a reddish-brown hue. In the wild horse the dorsal band is sometimes very narrow (under 5mm.) and indistinct. In the Kiang sire there are pale but quite distinct stripes above and below the hocks, and small faint spots over the hind quarters—vestiges, apparently, of ancestral markings; but in the hybrid there are neither indications of stripes across the hocks or withers, nor spots on the quarters.[1]

In having no indications of bars on the legs or faint stripes across the shoulders, the hybrid differs from Przewalsky colts; it also differs in having a longer flank feather, and in the facial whorl being well below the level of the eyes. As in the Kiang and wild horse, the under surface of the body and the inner aspect of the limbs are nearly white.

In the hybrid the front chestnuts (wrist callosities) are smooth and just above the level of the skin, but instead of being roughly pear-shaped as in the Kiang, they are somewhat shield-shaped, as in the Onager. In the wild horse the front chestnuts are elongated.

In the Exmoor dam the hind chestnuts (hock callosities) are 27mm. in length and 10mm. wide. In the sire there is a minute callosity inside the right hock. In the hybrid the hind chestnuts are completely absent. In the absence of hock callosities the hybrid differs from the wild horse, in which they are relatively longer than in Clydesdales, Shires, and other heavy breeds of horses. In the hybrid, as in the sire and dam, there are smooth, rounded fetlock callosities (ergots) on both fore and hind limbs.

In the wild horse the hoof is highly specialised, the "heels" being bent inwards (contracted) to take a vice-like grip of the frog. In the hybrid the hoof closely resembles that of the pony dam; it is shorter than in the Kiang, and less contracted at the "heels" than in the wild horse.

The Kiang hybrid further differs from a young wild

[1] The wild parent is generally prepotent over the tame—in Mendelian terms the Kiang proved dominant, the Exmoor pony recessive.

[2] For a skin of a very young Przewalsky foal I am indebted to Mr. Carl Hagenbeck, of Hamburg.

[1] The complete absence of stripes in the Kiang hybrid is all the more interesting, seeing that the dam's previous foals were zebra hybrids. Evidently the Kiang hybrid lends no support to the telegony doctrine.

horse in the lips and muzzle, the nostrils and ears, and in the form of the head.

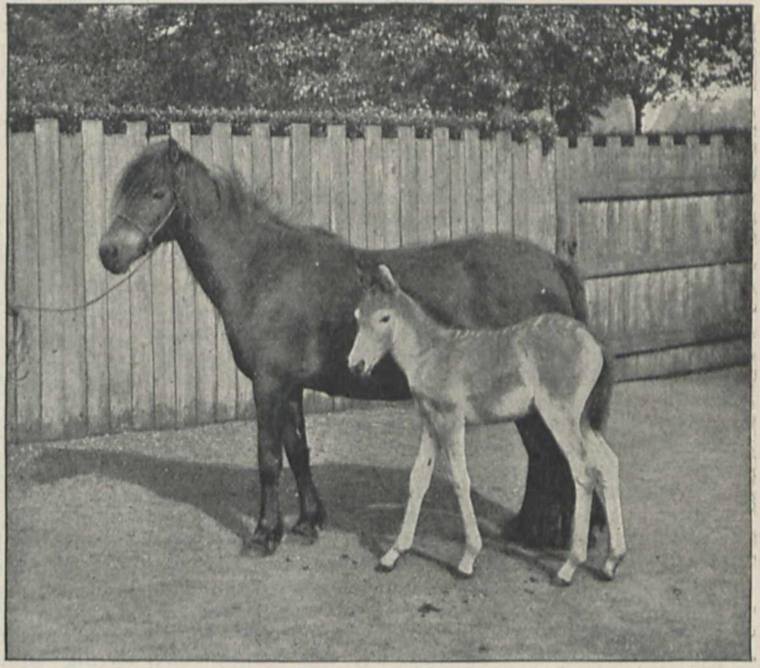
The wild horse has a coarse, heavy head, with the lower lip (as is often the case in large-headed horses and in Arabs with large hock callosities) projecting beyond the upper. The nostrils in their outline resemble those of the domestic horse, while the long pointed ears generally project obliquely outwards, as in many heavy horses and in the Melbourne strain of thoroughbreds. Further, in the wild horse the forehead is convex from above downwards, as well as from side to side—hence Przewalsky's horse is sometimes said to be ram-headed. In the hybrid the muzzle is fine as in Arabs, the lower lip is decidedly shorter than the prominent upper lip, the nostrils are narrow as in the Kiang, and even at birth the forehead was less rounded than is commonly the case in ordinary foals. The ears of the hybrid, though relatively shorter and narrower than in the Kiang, have, as in the Kiang, incurved dark-tinted tips, and they are usually carried erect or slightly inclined towards the middle line. In the wild horse the croup is nearly straight, and the tail is set on high up, as in many desert Arabs. In the hybrid the croup slopes as in the Kiang and in many ponies, with the result that the root of the tail is on a decidedly lower level than the highest part of the hind quarters. Further, in the young wild horses I have seen the heels (points of the hocks) almost touch each other, as in many Clydesdales, and the hocks are distinctly bent. In the hybrid the hocks are as straight as in well-bred foals, and the heels are kept well apart in walking.

Another difference of considerable importance is that while the wild horse neighs, the hybrid makes a peculiar barking sound, remotely suggestive of the rasping call of the Kiang.

The dun Mongol pony's hybrid arrived five weeks before its time, and, though perfect in every way, was short-lived. Only in one respect did this hybrid differ from the one already described. In the Exmoor hybrid the hock callosities are entirely absent; in the Mongol hybrid the right hock callosity is completely wanting, but the left one is represented by a small, slightly hardened patch of skin sparsely covered with short white hair.[1] In zebra hybrids out of cross-bred mares the hock callosities are usually fairly large, while in hybrids out of well-bred ("Celtic") pony mares the hock callosities are invariably absent. The Exmoor pony, though not so pure as the Hebridean and other ponies without callosities, has undoubtedly a strong dash of true pony blood; the Mongol pony is as certainly saturated with what, for want of a better term, may be called cart-horse blood. As I expected, there were no hock callosities present in the Exmoor hybrid. In the Mongol hybrid there was less evidence of hock callosities than I expected.

From what has been said it follows that a Kiang-horse hybrid differs from Przewalsky's horse (1) in having at the most the merest vestiges of hock callosities; (2) in not neighing like a horse; (3) in having finer limbs and joints and less specialised hoofs; (4) in the form of the head, in the lips, muzzle, and ears; (5) in the dorsal band; and (6) in the absence, even at birth, of any suggestion of shoulder-stripes and of bars on the legs.

While most of the zoologists who hesitated to regard Przewalsky's horse as representing a distinct and primitive type favoured the view that it was a mule, some asserted that it in no way essentially differed from an ordinary horse. The colts brought from Central Asia, they said, were the offspring of escaped Mongol ponies. Others affirmed that they failed to discover any difference between the young wild horses in the London Zoological Gardens and Iceland ponies of a like age. To test the first of these assertions, I, as already mentioned, mated the chestnut Mongol pony with a young Connemara stallion; to test the second, I purchased last autumn a recently-imported yellow-dun Iceland mare in foal to an Iceland stallion. As I anticipated, the chestnut Mongol mare produced a foal the image of herself. This foal, it is hardly necessary to say, decidedly differs from the Przewalsky colts recently imported from Central Asia by Mr. Hagenbeck, and it as decidedly differs from the Kiang hybrids described above.



E. Darwin-Wilmot.

FIG. 3.—Exmoor pony and her Hybrid foal, *æt.* 9 days.

The Iceland foal, notwithstanding the upright mane and the woolly coat, for a time of a nearly uniform white colour, could never be mistaken for a wild horse, and the older it gets the differences will become accentuated.

If Przewalsky's horse is neither a Kiang-pony mule nor a feral Mongolian pony, and if, moreover, it is fertile (and its fertility can hardly be questioned), I fail to see how we can escape from the conclusion that it is as deserving as, say, the Kiang to be regarded as a distinct species. Granting Przewalsky's horse is a true wild horse, the question arises: In what way, if any, is it related to our domestic horses? It is still too soon to answer this question; but I venture to think that should we, by and by, arrive at the con-

[1] The presence of hair in the imperfectly-formed hock callosity of the Mongol hybrid, together with the presence of hair rudiments in the developing hock callosity of the common horse, certainly lends very little support to the view held by some zoologists that the chestnuts of the horse are vestiges of glands.

clusion that our domestic horses have had a multiple origin—have sprung from at least two perfectly distinct sources—we shall probably subsequently come to the further conclusion that our big-headed, big-jointed horses, with well-marked chestnuts on the hind legs, are more intimately related to the wild horse than the small-headed, slender-limbed varieties without chestnuts on the hind legs; that, in fact, the heavy horses, whether found in Europe, Asia, or Africa, and Przewalsky's horse have sprung from the same ancestors.

HIGHER TECHNICAL EDUCATION IN GREAT BRITAIN AND GERMANY.[1]

H.M. Consul at Stuttgart, Dr. Frederick Rose, has rendered excellent service to the cause of technical education by the admirable reports which he has from time to time sent to the Foreign Office; but no previous report of his presents such a clear view of the extent of the provisions for technical education in Germany and of the nature of the services which the technical high schools render to the nation as does the one recently published by the Foreign Office.

Dr. Rose is not a mere blind enthusiast for education, unable to see the other factors which have made for the commercial progress of Germany. On the contrary, he gives due weight to the system of protection, the orderly habits inculcated by the universal system of military service, and other matters which contribute in this direction; but after doing this he is still compelled to recognise the great part played by the German technical high schools in the industrial development of the nation.

The object of this article is to compare the condition of technical education in the United Kingdom with the condition in the country with which Dr. Rose deals; unfortunately, the comparison is one calculated to give Englishmen little satisfaction.

In this country we have a fairly large number of technical institutions with many thousands of students; indeed, in numbers only, it is probable that we should compare not unfavourably with our German cousins. But when we look more closely into the statistics we find that in most of these institutions the majority of the students are attending evening classes only, and that of this majority a very large number are engaged in work of an exceedingly elementary character. If one considers the day students and restricts oneself to those who are above the very low minimum age of fifteen, it is found that, counting not merely the technical institutions, but also the universities and university colleges, the total number of day students for the United Kingdom amounted in 1901 to less than 4000. The corresponding total for the German Empire was, in 1902, nearly 15,000.

These figures, as they stand, are sufficient to show how very backward we are in this country in the matter of higher technical education; but, when we bring into the comparison the ages and previous education of the students of the two countries, we see that the above figures by no means adequately show how far we are behind the foreigner in the matter of training. For it must be remembered that, with very few exceptions, all students in German technical high schools commence their studies when they are not less than eighteen years of age, and after passing with credit a nine years' course of instruction in secondary schools. We may estimate that of the 4000 students over fifteen in institutions in the United Kingdom providing technical education in the day-time, at least 1400—probably considerably more—were under eighteen; this reduces us to 2600 students to compare with the 15,000 of Germany.

Nor is this all; for, while the majority of the German students pursue their course of study for at least three years, and in many cases for four, in this country only a very small proportion proceed beyond two years; thus it was found that in 1901 there were about 400 third or fourth year students taking complete day courses in engineering in the *whole United Kingdom*; at the same time there were in the Berlin Technical High School *alone* more third and fourth year students of engineering than in all the universities and colleges of the United Kingdom put together; moreover, none of these German students were under twenty, while our figures could only be obtained by counting every student of this standing over seventeen.

To what must we attribute our great inferiority in this respect? In the first place to the condition of secondary education in this country; secondly, to the fact that German and American manufacturers believe in technical education, while many of their competitors in this country are still blind to its advantages; and thirdly to the fact that, while our Government contributes with liberality to elementary education, it is exceedingly parsimonious in its dealings with higher education.

First, then, let us look at the question of secondary education. Dr. Rose's report gives an adequate idea of the splendid character of the preliminary training which young Germans receive before they enter the technical high schools or other higher institutions in Germany. The secondary schools to which he refers are accessible to children of intelligence all over the Empire; they are carefully graded so as to overlap one another as little as possible, and every inducement is given to parents to allow their children to pursue a complete course of study. The leaving certificates of these schools confer upon children the right of entry to the universities and technical high schools, while they also form a starting point for those who wish to enter the more important branches of the State service, and confer the right to escape part of the compulsory military training. We may hope that in this country the new education authorities will improve our secondary education. Is it too much to expect that the Government may issue a leaving certificate conferring similar privileges to the German one, and taking the place of the medley of university local, Board of Education, Army, Navy, and Civil Service examinations, and many others, which now hang like mill-stones round the necks of the teachers in secondary schools.

The problem how to make British manufacturers believe in technical education is one which is slowly solving itself, and within the recollection of the present writer an improvement in this direction has taken place. That the improvement has not been more rapid is partly due to the fact that in this country the imperfectly trained student has been over-confident in his own powers to an extent only explicable by considering the shortness and imperfection of his training. The half-educated, college-trained youth has thus often become a laughing-stock in the shops; he has given his opinions freely, and they have not infrequently been wrong.

In some of the best technical institutions we are altering all this; our students are made to understand that the preliminary training they receive is only a preliminary training, enabling them to acquire more complete knowledge later, but not entitling them to

[1] "Report on the German Technical High Schools." By Dr F. Rose, H.M. Consul, Stuttgart. (No. 591, Miscellaneous Series of Diplomatic and Consular Reports.)

Since this article was written, Lord Rosebery's letter has appeared, foreshadowing the establishment of a technical high school approximately on the Berlin scale in London. But the writer lets the article stand; for one such institution will scarcely suffice for the ultimate needs of the metropolis alone. It may be hoped, however, that similar developments will occur in our other great centres of population.

become critics. Our manufacturers, on the other hand, are learning to value young men who have had a sound training, and it is becoming less and less difficult each year to find suitable places for students of this kind, even though many of the students are prolonging their training longer than was the case some years ago, though still for a far shorter period in most cases than is the case with the German students.

In estimating the amount of assistance which the State gives to higher technical education in this country we are confronted with a serious difficulty, for the institutions in which such education is given are seldom concerned with this work only. The technical institutions spend much of their energy and financial resources on elementary work in evening classes, while in some cases they also include preparatory day departments, which are simply secondary schools of a modern type. In the university colleges which provide higher technical education, such work represents, as a rule, only a small fraction of their activity.

It is, however, quite certain that comparatively little of the grants made to technical institutions and university colleges can be considered as given specifically for higher technical education. Indeed, in so far as the former are concerned, the present policy of the Board of Education is to give high grants for secondary schools and elementary evening classes with numerous pupils, and but little aid to the day classes for adults, which form the most important part of the work of the best technical colleges.

The Scottish Education Department, on the contrary, has recently altered this for Scotland by selecting the institutions at Glasgow, Edinburgh, and Dundee, and putting them in a position of great liberty to develop their higher work, while promising to give aid, not so much for thousands of students doing elementary work as for the high quality of the advanced work done by a smaller number of persons. May we not hope that in England the authorities will soon adopt a similar policy?

As to Germany, Dr. Rose's report mentions the following facts. The Prussian State gave to the Berlin Technical High School alone, in 1871, an annual subvention of 8511*l.*; this grant has been gradually increased until, in 1899, it amounted to 33,675*l.*, while in the same year the total grant to the three Prussian technical high schools reached the sum of 65,350*l.*, being more than half the total revenues of these institutions. But besides these amounts, sums are independently voted by the Prussian Ministry of Finance towards meeting extraordinary expenses incurred for new buildings, machinery, apparatus, &c. If these sums be taken into consideration, we reach the grand total of 121,348*l.* a year. It must be remembered that these figures relate not to the whole of Germany, but simply to the kingdom of Prussia, with an industrial population many times less than that for which we have to provide leaders in the United Kingdom.

One of the tables in Dr. Rose's report shows in a remarkable way the great progress which has been made in the matter of higher education in Germany since the Franco-Prussian War. For the attendance of students at the German universities, technical, agricultural, and veterinary high schools, &c., has increased from 17,761 in 1870 to 46,520 in 1900; or to state the matter in another way, there were in such institutions in 1870 about nine students for every 10,000 male inhabitants of Germany, while in 1900 there were nearly seventeen students for every 10,000 male inhabitants. The rate of increase has been much more rapid in the technical high schools, though the universities also have made progress; the actual figures given by Dr. Rose are:—for the universities, 13,674 students in 1870, and 32,834 in 1900; for the technical high schools, 2928 in 1870, and 10,412 in 1900, irrespective in each instance of students in agricultural and mining high schools and other higher institutions. We see, then, that the attendance at the technical high schools has increased nearly fourfold during the thirty years, while in the same period the university students have become only about two and a half times as numerous.

An important point in Dr. Rose's report is that in Germany the technical high schools are independent of universities, although in some of the largest towns, such as Berlin and Münich, universities and technical high schools both flourish, existing side by side, and in some cases apparently overlapping, but not really so doing, since the object of the two institutions is not the same. The university students may be supposed to seek knowledge mainly for its own sake, while students in technical high schools propose to put their knowledge to commercial uses.

There is no doubt that this separation of technical work from the control of the university professors has been a good thing for both classes of institutions, which are now recognised as of equal standing in Germany by the action of the Emperor, as King of Prussia, followed shortly after by the King of Württemburg, whereby the technical high schools have the right of conferring the degree of doctor of engineering, thus putting them on a par with the universities in this respect. This action was taken notwithstanding the strong opposition of the Prussian universities, and the Emperor at the same time admitted the principals of the Prussian technical high schools to the Prussian House of Lords, and bestowed upon each of them the title of "His Magnificence."

Perhaps the most important lesson to be learnt from Dr. Rose's report is the need for the strengthening of the best technical institutions in England which provide for the training in day classes of our industrial leaders.

The report shows that in Germany higher technical education is concentrated in a limited number of institutions, and these the State makes thoroughly efficient. The result is the gathering into a single institution of such a large number of students that it is possible to provide for them buildings, equipment, and teaching staff on a scale far in advance of anything found here. Thus the teaching staff of the three Prussian technical high schools numbered in 1899 no less than 554, being one teacher for each nine students in attendance. This liberal staffing enables the German teachers to specialise, greatly to the advantage of the country, the students, and the teachers themselves. In Germany a man is not—as is the rule here—expected to deal with the whole range of such enormously wide subjects as, *e.g.* electrical engineering. One teacher has a thorough knowledge of central station equipment, another of telephony, a third of electro-motors, a fourth of electro-plating, and so on.

It is evident, then, that, if we wish our higher technical training to be as good as that of the Germans, we must concentrate our students. But this has been difficult, because our technical education has been so largely in the hands of local authorities; these bodies are naturally anxious to give the highest form of training for many industries within their own limits, but they are not, as a rule, willing to expend the very large sums needed to make this possible; nor would such an expenditure be wise. We have, therefore, in the United Kingdom a comparatively large number of institutions each attempting—for the most part inefficiently—to do the highest work in many branches of technology.

If imperial patriotism would but outweigh local partiality, the sums already available might go further than they do at present to provide better training for our industrial leaders. In London one may hope that this may be effected by inducing certain institutions to specialise in given directions. To take a case in point, the buildings, equipment, and numerical size of the staff of the Central Technical College might be equal to dealing satisfactorily with one branch of engineering or of applied chemistry. At present the college undertakes nearly all branches, and does it remarkably well, considering the difficulties under which it labours. If all the teaching staff for higher work in London were amalgamated, it would still be inferior in quantity—and, probably, in quality for *specialised* work—to that at Berlin; but it would not be, as is at present the case in the more or less isolated institutions, far too small for the work it is trying to do.

In the provinces the problem is more difficult, but not insoluble, if we are all more anxious for the good of the nation than for the glory of our own town or institution. Elementary technical education is needed in all the towns, but technical colleges are wanted in a few great cities only; and even in these populous centres every important branch of technology cannot be taught with efficiency, because, for a long time, there will be too few students to warrant adequate expenditure. Why should Sheffield and Leeds, *e.g.* both attempt the highest work in metallurgy and mining? Might not Sheffield send, say, its mining teachers and students to Leeds for higher work, and Leeds return the compliment by helping to develop the highest possible training in, say, metallurgy at Sheffield?

The case mentioned is only one instance of a principle which the Government ought to seek to establish generally, and to induce local authorities to adopt by offers of suitable grants in aid of what is really a pressing national need, viz. the development and improvement of our higher technical training. Each of the great cities might be made a centre for the highest training for one or more of our national industries, and the neighbouring cities should be willing to act as feeders to it in respect of this higher work.

Unless some such policy be adopted, there seems but little chance that we shall ever be able to offer a training equal to that available in Germany. For it would require enormous and wholly unnecessary expenditure to develop into a first-class technical high school dealing with many branches of technology, every technical institution and university college which is at present attempting to give some form of higher technical training.

Above all, let us note that both in Germany and America the flourishing technical colleges are not, as a rule, under the control of the universities, but exist side by side with them as co-equal organisations with different aims. To subordinate higher technical education to ordinary academic control would be to make a mistake which our German and American cousins have carefully avoided. Technical institutions might, however, very well become constituent parts of a university, provided, as has, *e.g.* been arranged at Sheffield, that they retain a sufficient measure of self-government. The scheme of Prof. Riedler, which Dr. Rose quotes with approval, would be a very good basis upon which to make a division between the work of our technical institutions and university colleges which exist in the same area, and, to some extent, overlap one another.

The university college might embrace, as Riedler proposes for the universities of Germany, the faculties of law, theology, medicine, philosophy, languages, history, State science, art, mathematics, and natural science; while the technical institutions would on his plan embrace the faculties of engineering, mining, forestry, agriculture, military science, and applied chemistry.

Finally, it may be well to quote the words in which Dr. Rose summarises the results of his extensive inquiries:—"The technical high schools cannot boast of the proud traditions of the old universities, nor are their buildings and institutions regarded with those feelings of gratitude and reverence which a long and honourable career in the service of humanity naturally inspires; but in default of this they can point to an almost perfect organisation and equipment for modern requirements, and to a development within the last forty years almost unparalleled in the annals of educational history." May a similar statement be possible ere long in regard to our own higher technical institutions! J. WERTHEIMER.

THE TENTH "EROS" CIRCULAR.[1]

"AS an example of needless duplication, fifty observatories agreed to observe the planet Eros during its opposition in 1900, but so far as known, only two or three have made the reductions needed to render their observations of any value." So wrote Prof. E. C. Pickering in April, in his "Plan for the Endowment of Astronomical Research"; and he is not alone in asking, directly or indirectly, when we may expect to have the result of all the work done at the opposition of 1900-1. The tenth Eros circular, dated June 1, appears at the right moment as a provisional reply. It gives the results of equatorial observations at twelve observatories, all compared with the ephemeris; and two splendid series of photographic observations made at Bordeaux and Paris, completely reduced so as to show not only the comparison of the planet's place with the ephemeris, but a series of places for individual stars such as has never been given before. If these two observatories had done nothing else in the two years elapsed since the plates were taken, they might be congratulated on a fine piece of work. Other results will doubtless follow now that these are in print to act as an incentive, and we need have no fears for the ultimate result.

It is, however, well to remember that the opposition of Eros came upon us at a time when our hands were already more than full with the ordinary work of the astrographic catalogue. It was an embarrassing choice whether to put aside the catalogue measures for a time, to finish them before undertaking the Eros work, or to try to do both simultaneously. The various observatories have selected one or other of these alternatives according to the stage which the catalogue work had reached. At Bordeaux and Paris a leisurely programme has been adopted for this work; the French Government has supplied ample means, but the vote has been spread over twenty-five years, and the work will be extended over the same period. It would have been ridiculous to defer the measurement of the Eros plates for any period of this kind, and we imagine the catalogue work has been put aside in order to measure the Eros plates. At Oxford, to take a different case, the catalogue work has been pushed forward rapidly so as to make the best use of the small sum available, and is on the point of completion. The Eros work can then be taken up without undue delay. At other observatories some compromise has doubtless been adopted between these extreme courses. So long as the work goes forward on the lines of least resistance there is no particular need to be anxious; and we welcome the appearance of the tenth circular as an outward and visible sign of the vitality of this research, which some were beginning to accuse of hibernation.

[1] Conférence Astrophotographique Internationale de Juillet 1900. Circulaire No. 10. Pp. 318 Paris, 1903.)

The results already published tempt one sorely to estimate a provisional parallax. Indeed there is no need to resist the temptation if one keeps the results to oneself, and avoids multiplying provisional results in print which only make confusion. An excellent example of reticence has already been set. This much may be said from experience; if anyone indulges himself by studying the results in the tenth circular, he will find no reason to be dissatisfied with the accuracy of the work.

The circular concludes with 100 pages of tables for facilitating the photographic reductions. Such tables may be thrown into an endless variety of forms according to individual taste; and the differences between any two particular arrangements are not of much importance compared with the great advantage of having the tables published. The thanks of everyone who measures photographs are due to M. Lœwy for his tables in the tenth circular. H. H. TURNER.

NOTES.

WHEN it was announced, a few months ago, that Prof. von Neumayer, the distinguished meteorologist, was about to retire, on account of advanced age and ill-health, from his post of director of the German Naval Observatory at Hamburg, which was under his control for a considerable number of years, the rumour quickly gained currency in usually well-informed circles that his successor would not be a man of science but a naval officer. This rumour was discredited at the time by many people, but it proves to have been quite correct, for during the Kaiser's recent visit to Hamburg for the purpose of unveiling a statue to the Emperor William I., he summoned Captain Herz, of the Imperial Navy, to his presence, and informed him that he had been appointed to the vacant post with the rank of a Rear-Admiral. As the work of the observatory is necessarily so largely scientific, it may at first sight seem strange that a man, who, no matter how able he may be, is not a man of science, should be placed at its head. A similar arrangement, however, has been made in several other cases in recent years—as, for instance, in the construction department of the Navy, which until quite recently was under the supervision of scientific engineers, but is now in the hands of naval officers—and the explanation given is that a man of science in such a position is so overburdened with administrative work—for which, very possibly, he is not well fitted—that he has little or no time for scientific investigation. The naval authorities have, therefore, decided to utilise their investigators wholly for scientific purposes, and to place the work of organisation and administration into the hands of a naval officer who is a man of practical affairs.

A BUST of the late Sir William Flower, F.R.S., will be formally presented to the trustees of the British Museum by the "Flower Memorial Committee" on Saturday next, July 25. The ceremony will take place in the central hall of the Natural History Museum at 1.15 p.m. The bust will be unveiled by the Archbishop of Canterbury as the representative of the trustees of the museum.

PROF. W. J. McGEE has been elected chairman, and Dr. J. H. McCormick secretary, of the committee of arrangements for the eighth International Geographical Congress to be held at Washington, D.C., in September of next year.

A FEW weeks ago we recorded the unveiling of a monument of Pasteur at Chartres. We learn from the *British Medical Journal* that on July 12 another monument was unveiled in the commune of Marnes-la-Coquette in the presence of many well-known men of science. It was in the district of Marnes-la-Coquette that Pasteur established his laboratory for the study of hydrophobia, and it was there that he died.

THE seventy-first annual meeting of the British Medical Association will be held at Swansea on July 28–31, under the presidency of Dr. T. D. Griffiths. After the delivery of the presidential address on July 28, the Stewart prize will be presented to Dr. F. W. Mott, F.R.S. Dr. F. T. Roberts will deliver an address in medicine, and Prof. A. W. Mayo Robson an address in surgery. The scientific work of the meeting will be conducted in eleven sections—medicine, surgery, obstetrics and gynæcology, State medicine, psychology, pathology, ophthalmology, diseases of children, laryngology, tropical diseases; Navy, Army, and ambulance.

THE Wilts Archæological Society held a meeting at Stonehenge on Friday last, and the Rev. E. H. Goddard gave an account of the raising of the leaning stone. Mr. Story Maskelyne, in thanking Sir Edmund Antrobus for his invitation to visit Stonehenge, said that, by raising the leaning stone, the biggest stone of its kind in England, one of the most important pieces of archæological work he had known had been accomplished. People might quarrel about barbed-wire fences and rights of way, but in his opinion the greatest public right in Stonehenge was the preservation of the monument, and that the present owner was doing to the best of his abilities.

THE long excursion of the Geologists' Association will be made from July 28 to August 4. The head-quarters will be at Berwick-on-Tweed, and in the course of the week the coast at Scremerston, Burnmouth, Eyemouth, and St. Abb's Head, and the country inland along the Whiteadder, the Eildon Hills and Melrose, and a portion of the Cheviot Hills will be visited. Silurian, Old Red Sandstone, Lower Carboniferous, various igneous rocks and glacial drifts will be examined under the direction of Mr. J. G. Goodchild, with Mr. R. S. Herries as excursion secretary.

THE death is announced of Mr. J. Peter Lesley, who from 1872 to 1878 was professor of geology and Dean of the Faculty of Science in the University of Pennsylvania, and was recognised in America as one of the most competent experts on coal and iron mining. From an obituary notice in *Science* (July 3) we learn that he was born in Philadelphia on September 17, 1819, and after graduating at the university in 1838, served on the first geological survey of the State, when he paid especial attention to the coal-deposits. On the abrupt termination of the survey in 1841 he passed through a course of theology, was licensed to preach in 1844, and was for some years pastor of a Congregational church at Milton, Mass. His views, however, underwent some changes, and returning to Philadelphia he again took up geological work, making elaborate surveys of several coal and iron fields in different States. For twenty-seven years he was secretary and librarian of the American Philosophical Society, part of the time holding the geological professorship in Pennsylvania, and in 1874 taking charge also of the second geological survey of the State. This last post he retained until 1893, when he retired to Milton. He died on June 1.

A SEVERE earthquake was felt throughout the island of St. Vincent on the morning of July 21.

WE have received the official *Protokoll* of the third meeting of the International "Commission" for Scientific Aëronautics, which was held in Berlin on May 20–25, 1902.

The meeting was attended not only by the members of the "commission," but also by a large number of delegates from various countries interested in aëronautical investigation. A report of the proceedings has already appeared in this Journal (vol. lxvii. p. 137, December 11, 1902). The opening address by Prof. Hergesell, president of the commission, gives a very lucid summary of the work already attempted in the investigation of the upper atmosphere by international cooperation, and of the general results achieved.

The scientific balloon ascents on June 4 were made in broad northerly air-current, which covered nearly the whole of Europe. At Itteville (Paris) the balloon rose to 12,840 metres; the temperature at 10,490 metres was $-52°·6$ C.; at starting 9°·3. At Zürich, an altitude of 15,750 metres was reached, minimum temperature, $-66°·5$; at starting, 10°·2. At Berlin, a temperature of $-53°·0$ was recorded at 11,500 metres; at starting, 10°·2. At Vienna, $-43°·7$ was registered at 9500 metres; temperature at starting, 15°·8. At Pavlovsk, a kite rose to 4430 metres in the afternoon of June 3, temperature $-11°·6$; on the ground, 23°·0. A balloon sent up from Bath rose to about 14,000 metres; it descended in the sea, and the record is not published.

During the past week thunderstorms have been prevalent in various parts of the United Kingdom. In the early morning of Saturday last, a sharp storm occurred in the neighbourhood of London, and rainfall exceeding one inch and a half was measured; another storm occurred in the afternoon of that day, and further heavy rainfall occurred in parts of the metropolis. On Sunday severe storms were experienced in the southern counties; in parts of those districts the roads were under water for some time, and much damage was done to crops. The barometer readings were, for several days, generally low and uniform over the whole country, and although the weather has seemed to be "close," the thermometer has been low for the season, the day readings being at times as much as 10° below the average.

Dr. D. K. Morris, writing in the June number of the *University of Birmingham Engineering Journal*, gives an interesting description of the power transmission installation from St. Maurice to Lausanne. The installation is for the transmission of 5000 h.p. over a distance of 35 miles, and the chief interest in the scheme lies in the fact that high tension direct currents are used in place of alternating or three-phase currents. The choice of this system has enabled a much greater simplicity in switching gear to be attained without any loss in efficiency, which is stated to be as high as 94 per cent. The system is a constant current one, 150 amperes at all loads, the voltage varying with the power transmitted, and reaching a maximum of 22,300 volts. The generators at the St. Maurice power station are designed to generate 150 amperes at about 2000 volts, and are connected in series, more machines being put in circuit as the load rises. The high voltage involves very special precautions in the insulation not only of the machine windings, but also of the machines themselves. The windings are very carefully insulated in the ordinary way, and, in addition, all the active parts of the armature are separated from the support by micanite insulation; the machines are insulated from earth by heavy porcelain insulators in which the lower ends of the foundation bolts rest. The journal contains several other interesting contributions from the pens of students and others, and affords ample evidence of the flourishing condition of the engineering school at the university.

An interesting and rare case of infection of the mouth and subcutaneous tissues by a parasitic nematode worm is recorded by Mr. Whittles (*Lancet*, May 23). The patient had never been out of England, and the source of infection was surmised to be a pet Pomeranian dog. In a tropical disease affecting the skin, known as "craw-craw," a nematode has been described by Mr. O'Neil (possibly *Filaria perstans*), and the *bilharzia* may cause papillomatous growths.

An interesting and exhaustive report has been issued by the Worcestershire County Council upon the bacterial treatment of sewage by different methods, the analytical details being supplied by the county analyst, Mr. Cecil Duncan. The conclusion arrived at is that the best method for the treatment of domestic sewage is a closed septic tank with bacterial beds filled with coke, which was found to be better than coal, brick or stone, two bacterial beds being provided to be used alternately to avoid ponding. As regards fish-tests of effluents, it is remarked that the Salmonidæ require a larger quantity of oxygen than the Cyprinidæ. Mr. Duncan gives details of the methods of analysis used, and suggests several modifications of those usually employed. For preparing ammonia-free water for analytical processes he has found that boiling ordinary distilled water with bromine-water (1200c.c. and three drops) for a few minutes is a rapid and trustworthy expedient.

The first edition of the Kew hand-list of the Coniferæ has been exhausted for some time, and the authorities have published a new edition, which brings up to date the catalogue of species now in cultivation in the gardens. The revision has been undertaken by Dr. Masters, who was also responsible for the first edition. There is a considerable increase in the number of varieties, but only a very slight addition of fresh species.

The necessity for adopting a uniform system of nomenclature in botany is sufficiently obvious, but at present this desirable condition has not been attained. In the presidential address delivered before the Linnean Society of New South Wales, Mr. J. H. Maiden presents a good summary of the codes which have been drawn up with this object, and enumerates the chief difficulties which confront the systematist.

Instances of the disappearance of uncommon or interesting plants in the neighbourhood of towns are unfortunately only too frequent, so that the gift of a small but particularly rich piece of land, presented by Mr. Willett to the Ashmolean Natural History Society of Oxfordshire, will appeal to all naturalists. The donor desired to perpetuate the name of his famous fellow-collegian, and suggested that the area should be known as the "Ruskin Plot." The unique character of the vegetation is due to the presence of oolite overlying the clay, and these provide the situation required by a number of orchids and sedges. Mr. G. C. Druce, who selected the spot, describes in a small pamphlet the interesting plants which are collected together.

Writing in the Lombardy *Rendiconti*, Prof. A. Martinazzoli urges the desirability of initiating anthropological observations in the Italian elementary and other schools. In view of the fact that hitherto nothing had been done in that direction, it is to be regarded as an indication of progress that during the last year about six anthropometric laboratories were fitted up in Italy, but it will be a long time before, from this small beginning, results are reached comparable with those achieved in the United States.

THE June number of *Biometrika* contains an interesting contribution to the discussion on Mendel's theory of inheritance by Prof. Weldon, in which further difficulties are put forward against the acceptance of the laws as interpreted and amended by Mr. Bateson. Mr. Darbishire gives, in the same number, his third record of the hybrids between waltzing mice and albinos, and Mr. Woods an account of his experiments in breeding rabbits as bearing upon the principles of the same theory. Among other interesting papers there will be found what appear to be preliminary attempts on the part of Mr. Geoffrey Smith to determine the mass relations of nucleus and cytoplasm in Actinosphærium, and of Dr. Warren to determine the relationship between the size of the cell and the size of the body in Daphnia. Further work in this very interesting but difficult field of research is much needed.

THE North American representatives of the widely spread group of diminutive ants, known as Leptothorax, are revised by Mr. W. M. Wheeler in the *Proceedings* of the Philadelphia Academy (pp. 215 *et seq*). The small size and concealed position of the colonies of these ants (which in general contain only from 25 to 50 individuals) account to a great extent for our imperfect knowledge of the group.

IN the June number of the *American Naturalist* Prof. B. Dean records partial and complete albinism, as well as polychromatism, in the hag-fishes. Since one species of the group is thus proved to possess a definite type of coloration, it is inferred that myxinoids, as a whole, can scarcely differ in this respect from true fishes, in which deep-sea forms are uniformly coloured, while shallow water types are variegated. Hence follows the further inference that the few existing forms are survivors of a once numerous tribe. Later on in the same issue Mr. C. J. Herrick discusses the sense-organs in the skin of fishes, and concludes that those species which possess terminal nerve-buds in the lateral line system of the outer skin detect and taste their food by means of these organs, while those which lack these structures in the skin have the sense of taste confined to the mouth.

AN extremely suggestive and interesting paper by Dr. Lewkowitsch, dealing with problems in the fat industry, appears in the *Journal* of the Society of Chemical Industry, vol. xxii. No. 10. The author is of the opinion that a fresh wave of inventive activity is approaching in the various branches of the fat industry, and in his paper points out a series of problems which await solution at the present moment. Industries having for their object the refining of fats and oils, industries in which the glycerides undergo a chemical change but are not saponified, and those industries based on the saponification of fats and oils, are all dealt with in the paper.

THE additions to the Zoological Society's Gardens during the past week include a Sooty Mangabey (*Cercocebus fuliginosus*), a Black Hornbill (*Sphagolobus atratus*) from West Africa, presented by Mr. T. Wright; two Arabian Gazelles (*Gazella arabica*) from Sheik Osman, Arabia, presented by Messrs. Wheatley and Glossop, R.N.; a Brazilian Tapir (*Tapirus americanus*) from South America, an Amazonian Manatee (*Manatus inunguis*) from the River Amazon, presented by Mr. Charles Booth; a Grey Squirrel (*Sciurus cinereus*) from North America, presented by the Lady Kintore; a Campbell's Monkey (*Cercopithecus campbelli*) from West Africa, a White Stork (*Ciconia alba*), European, deposited.

OUR ASTRONOMICAL COLUMN.

BRIGHT SPOTS ON SATURN.—Mr. W. F. Denning sends us the following approximate times of transit of two bright spots across the central meridian of Saturn, and the times of rising and southing of the planet during the next fortnight:—

1903	Spot "A" h. m.	Spot "B" h. m.	Saturn Rises h. m.	Saturn Souths h. m.
July 25	10 37	—	8 5	12 25
,, 26	—	14 18	8 1	12 21
,, 27	13 47	10 43	7 57	12 17
,, 28	10 12	—	7 53	12 13
,, 29	—	13 53	7 49	12 8
,, 30	13 22	10 18	7 45	12 4
,, 31	9 47	—	7 41	12 0
Aug. 1	—	13 28	7 36	11 56
,, 2	12 57	9 53	7 32	11 52
,, 3	9 22	—	7 28	11 47
,, 4	—	13 3	7 24	11 43
,, 5	12 32	9 28	7 20	11 39
,, 6	8 57	—	7 16	11 35
,, 7	—	12 38	7 12	11 31
,, 8	12 7	9 3	7 8	11 26
,, 10	—	12 13	7 0	11 18

The spots are separated by about three hours (=108°) of longitude, and are conspicuous objects when the planet is well defined.

SPECTROSCOPIC OBSERVATIONS OF NOVA GEMINORUM.—Photographs obtained in April by Prof. Perrine, using the Crossley reflector, show that, despite its reddish colour, the light from Nova Geminorum was rich in actinic rays. They do not show any trace of nebulosity around the star such as was obtained in the case of Nova Persei.

Spectrograms obtained with the small slitless spectroscope attached to the Crossley reflector, show that in the region photographed—$H\beta$ to λ 335—the spectrum somewhat resembles that obtained by Messrs. Wright and Campbell for Nova Persei in April, 1901, and consists of bright lines and bands superposed on a continuous spectrum; these lines are almost all accounted for by the hydrogen lines in that region. $H\epsilon$ and $H\zeta$, as well as the lines at λ 339 and λ 346, were the strongest lines in Nova Persei, but they are very weak in the recent Nova, whereas $H\beta$ and $H\delta$ are strong in the latter but very weak in the former spectrum; the chief nebular line, λ 501, which was conspicuous in the spectrum of Nova Persei, is not shown in these spectrograms of Nova Geminorum. These differences may be due to the different stages of development of the two stars.

A comparison of two spectrograms obtained on April 2 and 8 respectively, show a considerable alteration in the six days interval, particularly in the ultra-violet region, where the continuous spectrum became weaker and the bands at $\lambda\lambda$ 350, 374 and 384 consequently appeared stronger; λ 339 and λ 346 also appeared to have developed. $H\beta$ appeared weaker, and there was a faint condensation in the region of λ 501. This condensation appeared as a fairly well-marked line on a later photograph obtained on May 11. Visual observations showed a strong $H\alpha$ line and a condensation in the region about D_1 and D_2.

An ordinary photograph exposed on April 22, 23 and 24 for 6h. 29m. showed no trace of nebulosity around the Nova.

Reproductions of these region photographs and spectrograms, and a detailed account of the visual and photographic observations of Profs. Reese and Curtis accompany Prof. Aitken's article in Lick *Bulletin*, No. 37.

MEASUREMENT OF THE INTENSITY OF FEEBLE ILLUMINATIONS.—M. Touchet, of Paris, has devised an apparatus for measuring the intensities of such feeble illuminations as the Zodiacal Light and the Gegenschein. It is similar in appearance to a theodolite, but has a flame of constant illuminating power so arranged as to illuminate the field through a variable slit. This slit may be opened and closed, like the slit of an ordinary spectroscope, by a screw having a divided head, so that the intensity of the field illumination may be instantly made equal to that of the light it is desired to measure, and readings, which are reducible to a standard, thus obtained (*Bulletin de la Société Astronomique de France*, July).

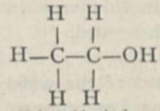
THE GERMAN ROYAL NAVAL OBSERVATORY.—The twenty-fifth annual volume (1902) of the publications of this observatory, entitled "Aus dem Archiv der Deutschen Seewarte," contains descriptive papers on "The Regulation of Marine Compasses," "A New Free-horizon Astronomical Base Line," "The Definitive Determination of the Path of the Comet Swift (1899.I)," and "The Results of Sextant Tests made at the Observatory.

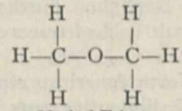
In addition to the introduction, Dr. Neumayer, the director, contributes an article on "A New Method of Forecasting the Meteorological Conditions of the North Atlantic Ocean," and a novel chart, indicating all the meteorological conditions obtaining in the North Atlantic area during March, 1902, accompanies the volume.

RECENT ADVANCES IN STEREOCHEMISTRY.[1]

IN the year 1803, just a century ago, John Dalton delivered a series of scientific lectures in the Royal Institution during the course of which he doubtless laid before his audience a theory which he had recently devised for the purpose of connecting together the vast number of isolated chemical facts known at the commencement of the nineteenth century. This theory, of which the centenary is being celebrated during the present month by the Manchester Literary and Philosophical Society, is known as the atomic theory, and was destined to form the foundation upon which the whole superstructure of modern chemistry has been built. For our present purpose Dalton's theory may be briefly stated in the form of the following two principles:—(1) Every element is made up of homogeneous atoms of which the mass is constant; (2) chemical compounds are formed by the union of atoms of the various elements in simple numerical proportions. In accordance with Dalton's hypothesis, chemical substances may be mentally pictured by imagining the atoms as small spheres which have the power of aggregating themselves together under suitable conditions to form complexes or "molecules"; thus, taking two similar spheres representing hydrogen atoms, in conjunction with a sphere of a different kind, representative of an atom of oxygen, a chemical representation can be given of the compound water, the molecule of which is composed of two atoms of hydrogen and one of oxygen. The original atomic theory offers no explanation of the observed fact that the atoms combine together in different proportions; this deficiency was remedied by the doctrine of valency enunciated by the late Sir Edward Frankland in 1852. Frankland supposed that the atoms of certain elements, such as hydrogen and chlorine, are unable to combine with more than one atom of any other element; these elements are termed monovalent. Other atoms, such as those of barium and zinc, can become directly attached to at most two other atoms; these are the divalent elements. Tri-, tetra-, penta-, hexa-, hepta- and octa-valent elements can be similarly distinguished, the valency of hydrogen being taken as unity, in order to measure and define the saturation-capacity or the atom-fixing power of the atoms of the other elements. It will be clear that for rough diagrammatic purposes we may provide the spheres representing the atoms with as many wooden pegs as the element itself exhibits units of valency; compound molecules can then be represented by fitting the atoms together by means of the pegs representing the number of valency-units possessed by the various constituent atoms. By so doing a great advance is made upon the atomic theory of Dalton's time, and a mental picture is obtained of the way in which the atoms are connected together within the molecule itself.

During the early part of the nineteenth century it became evident, principally from the work of Liebig and Wöhler in Germany, and of Faraday at the Royal Institution, that substances exist which possess totally different properties, but nevertheless have the same molecular composition; as this became slowly realised, the atomic theory was naturally called upon to furnish some adequate explanation. In view of the proven identity of molecular composition, the required explanation could only be sought for in differences in the atomic arrangement within the molecules of the several substances. That such differences can be successfully illustrated by the aid of the atomic models will be seen on considering some specific case. Ordinary ethyl alcohol and methyl ether differ greatly from each other—the first is a liquid, whilst the second is a gas at ordinary temperatures—but possess the same molecular composition, the molecule in each case consisting of two atoms of carbon, six of hydrogen and one of oxygen. These two substances have to be represented on the assumption that hydrogen is monovalent, carbon tetravalent, and oxygen divalent. By joining wooden spheres together in the order shown in the figures—in which the valencies of the component atoms are carefully respected—diagrammatic representations are obtained which illustrate to the chemist the differences existing between ethyl alcohol and methyl ether.

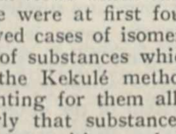

Ethyl Alcohol.


Methyl Ether.

Substances related to each other in this way are said to be isomeric; they have the same molecular composition, but different molecular constitutions. The step in advance which is involved in thus writing molecular constitutions or in constructing molecular models was taken by Kekulé in 1858.

Two great stages in the development of chemical theory have now been indicated. First, that contributed by Dalton, who regarded constancy of molecular composition as characteristic of a chemical substance; secondly, that further stage, attained as a result of the labours of Liebig, Wöhler, Faraday, Frankland and Kekulé, which involved the introduction of the idea that the chemical individuality of a substance is dependent upon its molecular constitution as well as upon its molecular composition. A third great development in the atomic theory had yet to take place.

Whilst the theoretical views which culminated in Kekulé's constitutional formulæ were at first found sufficient to explain numerous observed cases of isomerism, instances soon began to accumulate of substances which exist in so many isomeric forms that the Kekulé method of representation is incapable of accounting for them all. At an early date Pasteur showed clearly that substances exist which have the same molecular composition and the same molecular constitution, but which nevertheless differ in important respects. A crisis was ultimately reached when, in 1870, Wislicenus demonstrated the existence of three isomeric lactic acids, all having the molecular composition $C_3H_6O_3$, and the molecular constitution



and contended that he had amply proved the insufficiency of Kekulé's method of writing constitutional formulæ.

The step needed to rid the atomic theory of these apparent anomalies was indicated by van 't Hoff and Le Bel in 1871: they pointed out that the weakness of the Kekulé method lies in the tacit assumption that the molecule is spread out upon a plane surface, and that by throwing this assumption aside and taking a rational view of the way in which the molecule is extended in space, all difficulties immediately vanish. The considerations put forward by van 't Hoff and Le Bel form the basis of the subject now known as stereochemistry, the branch of science which deals with the manner in which the atoms are distributed within the molecule in three-dimensional space; they deal, in the first place, with the arrangement of the constituent atoms in the simple organic compound, methane, the molecule of which has the composition CH_4, or consists of one carbon atom and four hydrogen atoms. The Kekulé constitutional formula pictures the component atoms of the methane molecule as if joined together in one plane (Fig. 1), whilst according to the new view, the four hydrogen atoms are imagined situated at the four apices of a regular tetra-

[1] A discourse delivered at the Royal Institution on May 1 by Prof. William J. Pope, F.R.S.

hedron of which the carbon atom occupies the centre (Fig. 2). This is conveniently illustrated with the aid of a few cardboard models.

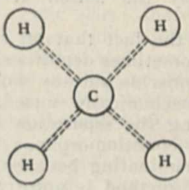


FIG. 1.

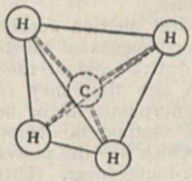
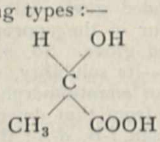
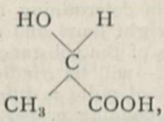


FIG. 2.

Consider now the result of replacing three of the four hydrogen atoms present in the methane molecule by three different groups of atoms, the three groups CH_3, OH, and CO_2H for example. One of the most striking results which has accrued from the chemical investigation of the past century has been the demonstration of the remarkable rigidity with which the atoms are held together in the molecule; it might therefore be anticipated that by actually making all the isomerides having the constitution indicated above, some means would be afforded of judging whether the van 't Hoff-Le Bel or the Kekulé view forms the closest approximation to truth. Kekulé's constitutional formulæ indicate the existence of two isomeric compounds of the following types:—



and



whilst on the van 't Hoff-Le Bel view, two isomerides of the nature illustrated by Figs. 3 and 4 are indicated; although in each case two isomerides would be obtainable, the examination of the two kinds of figure reveals very essential differences. The solid-figure isomerides differ only in that the one is the image in a mirror of the other—they are related in the same kind of way as a right and a left hand glove. The differences observable between two molecules thus related should consequently not be differences of an ordinary chemical nature, but differences involving merely a kind of chemical, physical and mechanical right- and left-handedness. The two Kekulé constitutional formulæ, on the other hand, would indicate—if they indicate anything—that the substances to which they refer differ in the more gross way in which ordinary chemical isomerides differ in chemical, physical and mechanical respect. That carbon atom which was present in the original methane molecule is, in these new compounds, now attached to four different atomic groups, and such a carbon atom is termed an "asymmetric" carbon atom. It is in the case of substances containing an asymmetric carbon atom that a lack of agreement is observed between the facts and the kind of isomerism indicated by the Kekulé

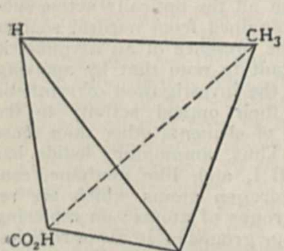


FIG. 3.

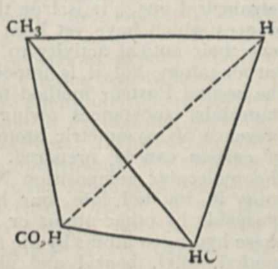
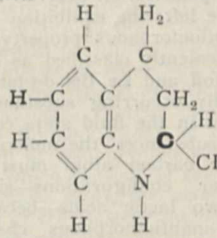


FIG. 4.

formulæ, and in these cases, also, the species of isomerism indicated by the solid models exhibited is found to correspond closely with the facts.

To illustrate this we may refer to a somewhat complicated substance, termed tetrahydroquinaldine, which has the following constitution:—



and the molecule of which contains an asymmetric carbon atom, that, namely, which is printed in heavy type. Three

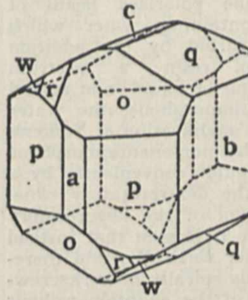


FIG. 5.

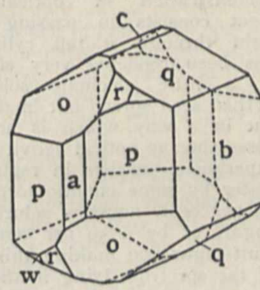


FIG. 6.

different isomeric forms of this substance exist, and are quite indistinguishable by any of the ordinary methods of chemical or physical identification; one of these is a loose kind of compound of the other two, and may therefore be disregarded for the moment. The remaining two have the same melting point, the same boiling point, and correspond exactly in all ordinary properties; they yield, however, series of derivatives which differ in the same sort of way that a right-hand and a left-hand glove differ. Here, for instance, is a diagram showing the shapes of the crystals of the salts which these two substances form with hydrochloric acid (Figs. 5 and 6); the crystals obtained from the one base are the mirror-images of those prepared from the other. Any figure which possesses handedness of the kind exhibited by these two crystal figures is termed "enantiomorphous," and two figures which are related to each other as these figures are related are said to be "enantiomorphously related." A hand is thus enantiomorphous, and a right and a left hand are enantiomorphously related, the one being the mirror-image of the other. Here, for example, is a photograph showing a right hand and a left hand side by side (Fig. 7); the pair of hands is exactly reproduced in the next photograph (Fig. 8), which shows a right hand side by side with the photograph of its reflection in a mirror. Just the same enantiomorphous relationship as that existing between the right and the left hand, exists between the molecular pictures of the two lactic acids discovered by Wislicenus, and shown in Figs. 3 and 4.

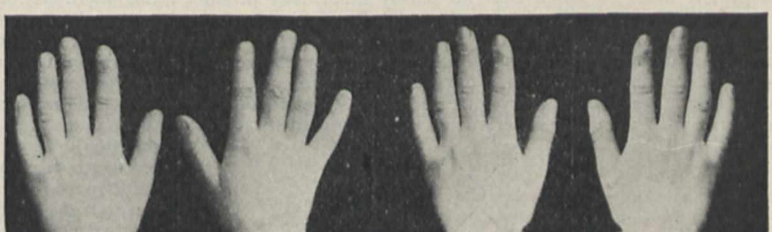
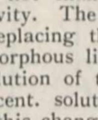


FIG. 7. FIG. 8.

Reference may now be made to the existence of other differences of an enantiomorphous character between substances which possess enantiomorphously related structures. Early in the last century the French physicists Arago and Biot showed that a number of substances have the power of deflecting the plane of polarisation of a plane-polarised beam of light thrown through their solutions. Such substances are said to be optically active, and since the deflection of the plane of polarisation may be either towards the right or towards the left, the exhibition of optical activity constitutes an enantiomorphous property; optically active substances are conveniently classified as dextro- and lævo-rotatory. Van 't Hoff and Le Bel declared that the molecules of all naturally occurring substances which exhibit optical activity when in the fluid state contain asymmetric carbon atoms. All substances the molecules of which contain an asymmetric carbon atom must possess enantiomorphous molecular configurations—similar to those assigned to the two lactic acids—because they exhibit properties of an enantiomorphous character. A very beautiful experiment which the late Sir George Gabriel Stokes devised may be so modified as to serve for the demonstration of optical activity. Stokes's experiment consists in passing a plane polarised beam of light through a tall cylinder containing water which has been rendered very slightly turbid by the addition of a little alcoholic solution of resin; a spectrum is then seen spread out in the column of liquid, and spread out in a way which is not enantiomorphous, the water possessing no optical activity. The modification of Stokes's experiment consists in replacing the non-enantiomorphous water by some enantiomorphous liquid—conveniently by a 70 per cent. aqueous solution of the dextrorotatory cane-sugar, or by a 50 per cent. solution of the lævorotatory fruit-sugar; on making this change it is seen that instead of the spectrum lying in the cylinder vertically, and therefore non-enantiomorphously, it winds spirally or corkscrew-wise round and round the column of the enantiomorphous liquid. The two spirals or helices are clearly enantiomorphous, and the two liquids of opposite optical activity give rise in this experiment to oppositely wound spirals—to spirals which are related to each other like the right- and left-handed corkscrews shown in the lantern slide. The opposite sign of the rotatory power exhibited by the cane-sugar and fruit-sugar solutions is more clearly shown by turning the polarising prism in its mount, when the two spirals turn in opposite directions.

Although cases of optical activity are very frequently met with among chemical substances of animal or vegetable origin, it must be noted that no purely laboratory product or substance prepared without the use of enantiomorphous operations or materials is, in the ordinary way, optically active. The reason of this needs but little seeking, if the solid tetrahedron models are once more consulted. Starting with a non-enantiomorphous substance is equivalent to starting with a methane derivative of the constitution



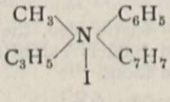
and replacing one of the two X groups by a fourth group Q so as to obtain a compound containing an asymmetric carbon atom. Obviously, unless some power of selection of an enantiomorphous nature is exercised in replacing X by Q, the doctrine of chance will ensure the one X group being replaced the same number of times as the other in an enormous number of tiny molecules. Thus there will result just the same amount of the right-handed optically active substance as of its left-handed isomeride. When an optically active substance is prepared in the laboratory, it is therefore obtained as a mixture of two enantiomorphously related isomerides; such a mixture is said to be compensated, because the right-handedness of the one component is just counterbalanced by the left-handedness of the isomeric constituent. These compensated substances are represented by the third lactic acid and by the third tetrahydroquinaldine previously referred to, but not further discussed.

Since one of the great problems with which chemistry is grappling involves the synthetic preparation of naturally occurring optically active substances, it is of the utmost importance that the chemist should be in possession of working methods for resolving these compensated mixtures into their optically active components. All the kinds of methods applicable to such resolutions necessarily involve the introduction of enantiomorphism—either of method or of material. Three types of methods were introduced by Pasteur, namely, (1) spontaneous resolution by crystallisation; (2) resolution by combination with optically active substances; and (3) resolution by the action of living organisms.

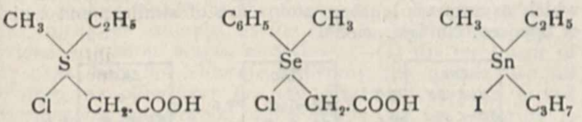
The first method depends upon the fact that on crystallising a compensated substance it sometimes deposits crystals of the dextro- and of the lævo-isomeride side by side, and of such size that they can be mechanically sorted. The enantiomorphous factor determining the separation in this kind of method is obviously the enantiomorphous intelligence which has the power of discriminating between right- and left-handedness. This sort of method is unfortunately but rarely applicable, owing to the fact that two enantiomorphously related substances usually crystallise together in the form of a loose chemical compound.

The second kind of Pasteur method is applicable to the resolution of compensated acids and bases, and depends upon the following considerations. On combining a compensated basic substance, viz. a mixture of *d*-B and *l*-B with an optically active acid—say with *d*-A—a mixture of two salts, namely *d*-B, *d*-A and *l*-B, *d*-A, will be obtained. These salts, however, are not enantiomorphously related, as will be realised on substituting for illustrative purposes a hand for the base and a glove for the acid; the combination *d*-B, *d*-A will then be represented by a right-hand in a right-handed glove, whilst the combination *l*-B, *d*-A will correspond to a left hand in a right-handed glove. The struggles of the left hand with the right-handed glove will not be a factor in determining the behaviour of the appropriately assorted right hand and right-handed glove. So, also, the properties of the substance *d*-B, *d*-A—its solubility, melting point, &c.—will be conditioned by an enantiomorphous relationship of quite a different order from that determining the corresponding properties of the salt *l*-B, *d*-A; the solubilities, being determined by different factors, will naturally also differ, and the two salts will therefore be separable by crystallisation. The first resolution of a compensated base was effected in 1885 by Ladenburg, and consisted in resolving the synthetic alkaloid coniine into its optically active components—one of which proved to be identical with the alkaloid contained in the juice of the hemlock—by crystallising it with dextrotartaric acid. Since this time the methods of resolving compensated bases have been materially improved by the application of optically active acids derived from camphor for use in place of the dextrotartaric acid, and an experiment in illustration can now be shown on the lecture table.

On adding a solution of ammonium dextrobromocamphorsulphonate to a solution of compensated tetrahydro-β-naphthylamine hydrochloride, a white crystalline precipitate of dextrotetrahydro-β-naphthylamine dextrobromocamphorsulphonate—the salt *d*-B, *d*-A—is thrown down, whilst the lævotetrahydro-β-naphthylamine remains in solution as its hydrochloride. The resolution in this, and in many other cases, can be very rapidly effected, and by still further applying the optically active sulphonic acids derived from camphor a considerable extension of the original van 't Hoff-Le Bel theory has become possible. These workers traced all cases of optical activity to the presence of an asymmetric carbon atom, and deduced from their work the conclusion that the environment of the carbon atom in methane is a tetrahedral one. It is true that all the optically active substances which have yet been obtained from natural sources owe their optical activity to the presence of an asymmetric carbon atom, but it is important to note that by applying the second Pasteur method to the investigation of synthetic materials, substances owing their optical activity to the presence of asymmetric atoms of elements other than those of carbon can be prepared. Thus, ammonium iodide has the molecular composition NH_4I, and, like methane, contains in its molecule four hydrogen atoms which are replaceable by other atoms or groups of atoms; on replacing these hydrogen atoms by the four groups of atoms or radicles, methyl, allyl, benzyl and phenyl, a substance is obtained which is conveniently named methylallylbenzylphenylammonium iodide, and has the following constitution:—



On replacing the iodine atom in this molecule by an optically active group of atoms, viz. by the dextrobromocamphorsulphonic residue, two salts are obtained, each of which contains an optically active basic part and an optically active acidic part; these are salts of the kinds *d*-B, *d*-A and *l*-B, *d*-A, and can be separated by crystallisation from a convenient solvent, and, after separation has been effected, each salt may be reconverted into the iodide. These regenerated iodides are found to be optically active in solution, and the conclusion is consequently drawn that optical activity is an attribute of the asymmetric pentavalent nitrogen atom as well as of the asymmetric tetravalent carbon atom. The optical activity of this substituted ammonium compound indicates that its molecule has an enantiomorphous configuration, and is extended in three-dimensional space; the exact nature of this configuration is not yet known, inasmuch as a space arrangement of five groups is concerned, but the environment of the nitrogen atom in ammonium salts is clearly not a simple tetrahedral one. Just as enantiomorphism has been proved to be an attribute of the asymmetric nitrogen atom, we have also demonstrated that asymmetric tetravalent atoms of sulphur, selenium and tin give rise to optical activity; optically active substances having the constitutions shown below have been prepared, and we are thus well on the way towards obtaining a complete stereochemical scheme embracing all the elements:—



It has been mentioned that optically active substances occur as such, rather than in the compensated form, in many animal and vegetable products, and also that when a substance containing an asymmetric carbon atom is prepared synthetically in the laboratory, it is of necessity obtained in the compensated form, or as a mixture in equal proportion of the dextro- and the lævo-isomerides. Taken together, these two facts have a very interesting bearing upon our speculations as to the origin of animal and vegetable life. Optically active substances have been isolated as products of the vital activity of all forms of animal or vegetable life which have been properly examined, but in spite of this they are never obtained directly as laboratory products; some enantiomorphous influence has always to be employed in their synthetic preparation, just as Pasteur applied enantiomorphism, either of method or of material, to the resolution of compensated substances. It was very strenuously argued by Prof. Japp, in his presidential address to the Chemical Section of the British Association in 1898, that no matter how successful we may be in reducing the problems relating to vital processes to mere questions of physics and chemistry, a residuum will always evade explanation by such means; this residuum will involve the discussion of the way in which the first enantiomorphous substance was resolved into its optically active components. This question involves the introduction of an enantiomorphous agency at some period during the evolutionary development of living matter. In attributing difficulty to the solution of this residuary problem, Dr. Japp implies that the enantiomorphous agency, the cooperation of which is essential, must be an intelligent agency. Let us ask ourselves whether the enantiomorphous agency premised is necessarily other than one acting fortuitously. The assumption of a fortuitously enantiomorphous agency is certainly all that need be made to explain the building up of many enantiomorphous systems. The dead universe itself, as we know it, is enantiomorphous, but this fact has never been regarded as a valid argument against the current hypothesis as to the cosmic origin of our planet. Some degree of obscurity is, however, introduced into the discussion of the primitive origin of the optically active substances now produced by animals and plants by the probability that ages of evolution have transformed the primeval optically active substance into multitudes of other and more complex products—have, in fact, accentuated the enantiomorphism to such an extent that physiological chemistry is now almost entirely the chemistry of enantiomorphous substances. If in any particular case, however, we can show that an optically active substance can be locally accumulated by the aid of some enantiomorphous agency acting purely fortuitously, it will be clear that the formation of the first optically active substance was not necessarily the work of an intelligent enantiomorphous agency. Such a species of separation of an optically active substance from a compensated one can be readily brought about in the laboratory. Pasteur showed that on crystallising the sodium ammonium salt of compensated tartaric acid (racemic acid) at ordinary temperature, large crystals separate, each of which consists of the salt of one or other of the *d*- and *l*-tartaric acids, the separation being brought about by the first of the Pasteur methods. If one of these crystals be selected casually, without the exercise of any selective intelligence, and used as a nucleus for inducing the crystallisation of further large quantities of the original solution, it will cause the separation of salt of its own kind, and ultimately a large quantity of salt of one of the optically active tartaric acids can be accumulated as a result of the introduction of an enantiomorphous agency such as might act fortuitously in a non-living universe. The probability of such a fortuitous agency arising would naturally be far greater in a living universe.

Again, suppose that at its origin life were carried on non-enantiomorphously, and that it involved the consumption and the production only of non-enantiomorphous substances and of compensated mixtures; it may well be foreseen that a stage in development might arise when each individual, in view of the increasing complexity of his vital processes, would have to decide to use only the one enantiomorphous component of his compensated food, and so evade an otherwise necessary duplication of his digestive apparatus. Acting unintelligently or fortuitously, one-half of the individuals would become dextro-beings, whilst the other half would become lævo-individuals; the succeeding generations would thus be of two enantiomorphously related configurations. It is, however, very difficult to believe that the natural selective operations which have been instrumental in conducting living organisms to their present stage of development would allow the perpetuation of this state of affairs for any considerable period; some fortuitous enantiomorphous occurrence would temporarily give the one configuration the advantage over the other, an advantage which would be quickly accentuated and would involve the permanent disappearance of the weaker configuration.

The kind of difficulties involved in the existence, side by side, of dextro- and lævo-individuals such as these may be shown by a simple illustration. There is no reason connected with human enantiomorphism why vehicular traffic should be forced to keep to one side of the road rather than to the other; as, however, the conditions of civilised life have gradually become more complex, economic reasons have arisen causing us to make an enantiomorphous selection, and in this country we arbitrarily force the traffic to keep to the left; other countries also make an arbitrary and sometimes a different selection. Even if, when legislation on this matter first became necessary, the population had been equally and obstinately divided upon the question of the rule of the road, we cannot doubt that by this time the question would have been satisfactorily and finally settled by the extermination of one or other of the enantiomorphously inclined parties without the cooperation of any intelligent enantiomorphous agency.

I mentioned that Pasteur gave a third method for the resolution of compensated substances, a method depending upon the selection exercised by living organisms upon the enantiomorphously related components of the mixture. He found, for instance, on allowing the mould *Penicillium glaucum* to grow in a solution containing compensated tartaric acid, that the mould used the *d*-tartaric acid as a food-stuff, and rejected the lævo-isomeride, which latter could ultimately be separated from the solution. The kind of method thus indicated has been applied with success in a great number of cases, and is, in the end, merely a special application of Pasteur's second method. During recent years a considerable change has taken place in our views upon the action of the lower organisms upon their food-stuffs. It was formerly supposed, for example, that the fermentation of sugar by an ordinary beer yeast is a part of the vital process of the organism itself—that the sugar taken in as food by the organism is finally thrown out in the form of carbon dioxide and alcohol; it is now clear, however, that the formation of these two products is in no way a vital process. By triturating yeast with powdered quartz, so as to shatter the cell walls, and expressing the pulp thus produced, Buchner has succeeded in obtaining a solution which, when mixed with sugar solution, converts the sugar into carbon dioxide and alcohol. The fermentation is therefore not a vital phenomenon, but is a chemical action induced by some non-living substance contained in the expressed juice of the yeast cells. This substance—zymase—has been isolated in the solid state, and belongs to the class of substances known as unorganised ferments or enzymes. Although many enzymes are known, each active in inducing the occurrence of some particular chemical change or changes, nothing is as yet known as to their molecular constitutions; ages of evolution have given such complexity to these substances that a century or less of chemical investigation has contributed practically nothing towards elucidating their nature.

During the investigation of cases of animal and vegetable vital activity, great numbers of instances of the action of enzymes have been found, the function of the enzyme being to bring about the molecular degradation and, in certain cases, the molecular complication, of more or less complex materials used or produced in the organism. As an example of molecular degradation due primarily to enzymic action, the action of zymase on grape-sugar—*d*-glucose—may be quoted. In aqueous solution, one molecule of grape-sugar becomes directly converted into two molecules of alcohol and two molecules of carbon dioxide, in accordance with the equation

$$C_6H_{12}O_6 = 2C_2H_6O + 2CO_2,$$

by the enzyme zymase. The enzyme itself suffers no permanent change as a result of exercising the power of causing this chemical reaction to take place, so that a comparatively minute quantity of the enzyme, acting for a more or less prolonged period, is able to convert an unlimited quantity of grape-sugar into alcohol and carbon dioxide. The power which the enzyme possesses of inducing the occurrence of some chemical reaction which otherwise does not take place is not peculiar to enzymes; many substances, which are all classed together as the so-called catalytic agents, are known to exercise the same sort of influence in assisting a chemical reaction to occur. Thus the action of finely divided platinum in causing certain inflammable gases to ignite in air at the ordinary temperature is a catalytic action. The particular function exercised by enzymes in animal or vegetable life consists in bringing about chemical change, quietly and continuously, without necessitating the application of any violent chemical effects such as we are in the habit of using in the laboratory. Although they proceed so quietly, the chemical changes thus effected are, in certain cases, changes which we have not yet succeeded in carrying out without the assistance of an enzyme; in the conversion of sugar into alcohol and carbon dioxide, zymase is performing a reaction which has never yet been brought about by the use of the ordinary laboratory methods.

Without quoting more specific instances, it may be generally stated that most of the cases of enzymic action hitherto investigated are cases in which a large molecular complex is degraded or broken down into substances of lower molecular weight. But it is important to note that the organism is also the seat of processes which result in the building up of very complex molecules from simpler ones, such, for instance, as the formation of starch from carbon dioxide and water. A specific case in which enzymic action leads to the production of a complex substance from simpler ones has been recently worked out by Fischer and Armstrong, who show that the enzyme, lactase, converts the sugar galactose, $C_6H_{12}O_6$, into a new sugar, isolactose, $C_{12}H_{22}O_{11}$, of nearly twice the molecular weight of the former.

All the enzymes with which we are acquainted appear to be enantiomorphous bodies; they are, perhaps, substances to which no definite molecular composition can ever be assigned, inasmuch as they may be systems consisting of a number of different true chemical compounds, the system being one which becomes endowed with extraordinary chemical activity when placed in a suitable environment. The enantiomorphism of the enzyme has been repeatedly demonstrated during the course of Emil Fischer's remarkable synthetic work on the sugars. Fischer succeeded in preparing fruit-sugar or fructose by purely synthetical methods as a mixture of the dextro- and the lævo-isomerides; in order to isolate the previously unknown *l*-fructose, he applied the third Pasteur method in that he cultivated a yeast in the solution of the compensated fructose. The yeast enzyme—presumably zymase—has arrived at its present stage of development by passing through countless generations, all of which have been fed upon sugars of the dextro-configuration, these being the only ones occurring in Nature. In Fischer's experiment the enzyme therefore readily devoured the *d*-fructose, but refused to touch the *l*-fructose, which had never before been presented to it. The *l*-fructose was, of course, subsequently isolated from the solution. The need for compatibility between the enzyme and the material upon which it has to act is very clearly illustrated by considering the effect of yeast upon a number of optically active and isomeric sugars. In the table (Fig. 9) are given the constitutions of a number of sugars of the composition $C_6H_{12}O_6$, the configurations of the three or four asymmetric carbon atoms present in the molecule being indicated by writing the hydrogen atoms on the right or the left of the figure, as the case may be; the right or left hands indicate which asymmetric carbon atoms are of similar, and which of opposed, configurations.

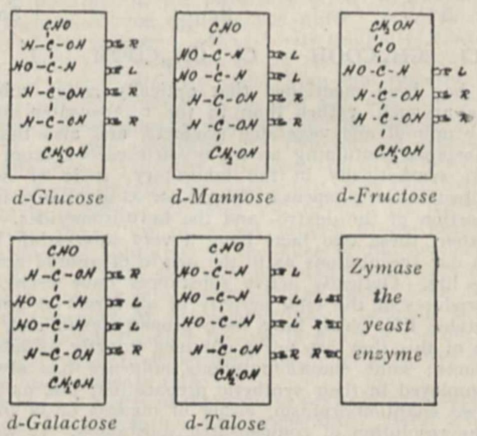


FIG. 9.

The beer yeast ferments *d*-glucose, *d*-mannose and *d*-fructose, each of which contains in the molecule a set of three asymmetric carbon atoms of similar configuration, with about equal readiness; *d*-galactose is, however, only fermented with difficulty—in the set of three asymmetric carbon atoms referred to, it contains one differing in configuration from the corresponding one in the three easily fermentable sugars. *d*-Talose, in which two of the three asymmetric carbon atoms differ in configuration from the corresponding carbon atoms in *d*-fructose, is quite unaffected by the yeast. It is just as if the enzyme were provided with three hands, in the order right, right, left, to enable it to grip the sugar molecule and commence tearing it to pieces; with these three hands it grips the corresponding hands—also of the configuration and order, right, right, left, of the first three sugars. The enzyme can, however, only grip the *d*-galactose molecule by two hands, and so obtains a less firm hold. Owing to the greater incompatibility between the zymase and the *d*-talose, the former obtains too feeble a hold on the latter to enable it to make a successful assault, and the sugar therefore remains unfermented.

The fact that the chemical reactions of animal and vegetable physiology consist, in the main, of the production or destruction of optically active substances through the agency of enantiomorphous enzymes is one of enormous importance. The complex substances concerned, such as starches, albumins and food-stuffs generally, occur in Nature in but one of the enantiomorphously related configurations; all the albumins are lævo-rotatory, all the starches and sugars are derived from dextro-glucose. Since Fischer's work teaches us that none of the sugars derived from lævo-glucose are fermentable by yeast, it would seem to follow as a legitimate conclusion that, whilst *d*-glucose is a valuable food-stuff, we should be incapable of digesting its enantiomorphously related isomeride, *l*-glucose. Humanity is therefore composed of dextro-men and dextro-women. And just as we ourselves would probably starve if provided with nothing but food enantiomorphously related to that to which we are accustomed, so, if our enantiomorphously related isomerides, the lævo-men, were to come among us now, at a time when we have not yet succeeded in preparing synthetically the more important food-stuffs, we should be unable to provide them with the food necessary to keep them alive.

CHLORINE SMELTING, WITH ELECTROLYSIS.

A PAPER on chlorine smelting with electrolysis was read by Mr. Swinburne at the first meeting of the Faraday Society; as the process described in the paper is of considerable interest, and may one day be of great importance, we give a brief abstract of the paper below.

The process is one for the treatment of complex sulphide ores, such, for example, as the Broken Hill slimes, and is divided into three stages as follows:—(1) the treatment of the ores with hot chlorine, whereby the metals are all obtained as chlorides; (2) the treatment of the mixed chlorides by substitution until finally all the chlorine is combined with zinc; and (3) the electrolysis of the zinc chloride to extract the zinc and recover the chlorine. The first stage of the process is carried out by blowing hot chlorine into the crushed ore in a "transformer"; the essential feature is to avoid the formation of chloride of sulphur.

This involves a careful regulation of temperature and of the rate of feed of the ore; the temperature can be easily regulated by the rate of feed of the ore and chlorine as the reaction evolves a great deal of heat, and the transformer is entirely self-heating. Advantage can be taken of the composition of the ore, as some of the metals have a greater heat of reaction than others; if necessary, a mixture of ores of different compositions can be made so as to give a satisfactory working material. The sulphur is set free and condensed. At the end of a charge the ore feed is stopped, and the excess of sulphides converted to chlorides, after which the fused chlorides are drawn off and dissolved; the gangue having been separated by filtration, the second part of the process begins. This naturally depends on the composition of the ore; lead, silver, and gold are separated with the gangue, and after drying are fused first with lead, which extracts the silver and gold, and then with zinc, which gives lead and zinc chloride, the former practically pure. The filtrate is treated with spongy copper to separate lead and silver, and then with zinc to take out the copper. Iron, manganese, and zinc chlorides are left; the iron is chlorinated up to the ferric state, and precipitated as ferric hydrate by zinc oxide, and further chlorination in presence of the zinc oxide throws down the manganese as peroxide. There is thus left only zinc chloride in solution, and this is evaporated down and fused. To it is added the fused chloride from the lead substitution, and the whole is electrolysed in vats made of iron lined with fire-brick. The heating is internal; the current and the chloride soaking into and solidifying in the fire-brick gives really a vat with zinc chloride walls. Vats taking 3000 amperes have been in use, but these are small, and 10,000 ampere vats are to be tried; the pressure required is less than four volts. The result of the process is pure zinc and chlorine ready for chlorination of fresh ore.

It will be seen that the chief merits of the process are its comprehensiveness, its cyclical nature, and the fact that it turns out pure metals. Obviously it is suited, with only slight modifications, for the treatment of a great variety of ores. The chlorine simply goes round and round; apart from leakage, which, as Mr. Swinburne says, if it would show on the balance sheet would make the works uninhabitable, chlorine can only be lost as chloride of sulphur (a source of loss the inventors claim to have overcome), and as oxychlorides formed in the iron separation and in evaporation of the zinc chloride, neither of great importance if care be taken. The works therefore simply take in ore and electrical energy and turn out metals, sulphur, and gangue. Mr. Swinburne enters at some length into the question of cost, but space does not permit of our following him here; we have said enough to indicate the interesting character of the paper, to which those more specially interested may be referred for further details.

M. S.

THE ROYAL INSTITUTE OF PUBLIC HEALTH.

THE annual congress of the Royal Institute of Public Health was held at Liverpool, July 15–21, under the presidency of the Earl of Derby. The sections met in the various departments of the University College, and were thus closely associated and readily accessible. The proceedings were opened by an interesting address from the Earl of Derby, in which he directed attention to the considerable progress in sanitation that had been made by many ancient civilisations. The Harben medals for 1901 and 1902 were then presented to Sir Charles Cameron and Prof. W. R. Smith.

A combined conference of the preventive medicine and municipal hygiene sections discussed the subject of tuberculosis, and Dr. Nathan Raw read a paper upon "The Prevention of Consumption in Large Cities," in which he expressed the opinion that consumption is frequently conveyed to children by milk from tuberculous cows, though patients in the advanced stage are the greater source of danger to the community. He suggested as means for controlling the disease (1) the establishment of a central office where consumptives might seek advice; (2) the erection of a municipal sanatorium which, for Liverpool, should contain 100 beds, and be within the reach of any needy citizen; and (3) the foundation of a hospital for the poor for at least 100 incurable cases. Several other papers dealing with tuberculosis were also contributed; one, by Mr. McLauchlan Young, who summarised the experiments performed by Prof. Hamilton and himself upon the communicability of bovine tuberculosis to man, and expressed the opinion that there could be little doubt that human tubercle can be readily inoculated upon bovines; another, by Drs. Dean and Todd, upon the communicability of human tuberculosis to the pig, in which the six animals experimented upon were all infected with the human bacillus. Thus there is already an accumulation of evidence against the view expressed by Koch at the Tuberculosis Congress of 1901, that bovine tuberculosis is probably not communicable to man.

In the section of bacteriology and comparative pathology, the president, Prof. Boyce, F.R.S., in his opening address directed attention to the connection between abstract research and the good of the community, instancing the value of bacteriological research to practical medicine, to the farmer, to the water engineer, and to the oyster merchant. A paper by Dr. Savage upon "A Uniform Method of Procedure for the Bacterioscopic Examination of Water," evoked an interesting discussion. He considered the subject under four headings:—(1) the methods of collection and transmission of the samples; (2) the data which it is desirable to ascertain; (3) the processes and procedures of the examination; and (4) the significance to be attached to the results obtained. It was ultimately resolved to form a committee to consider whether it might not be possible to systematise the methods, &c., to be used for the bacteriological examination of water.

Another important discussion, upon "the nature and significance of the pseudo-diphtheria bacillus," was opened by Dr. Cobbett, who expressed the opinion that this organism has nothing whatever to do with the true diphtheria bacillus. Prof. Hewlett stated that he was not yet convinced that the two organisms had no connection, and directed attention to several points of similarity between the two. Several medical officers of health held that, whether the two organisms had any connection or no, the pseudo-bacillus sometimes produced a diphtheritic condition. It is impossible to summarise the number of important papers that were read upon the housing question, child-study, port sanitation, and other subjects. Dr. Hope, the local secretary, is to be congratulated upon the arrangements made, and it is hardly necessary to add that Liverpool extended a hearty welcome to the delegates and members of the congress. R. T. HEWLETT.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

A REPORT on the scheme for the establishment, in London, of an institute for advanced technological instruction and research, recently put forward by Lord Rosebery, was presented to the London County Council on Tuesday. It will be remembered that the offer was made of land, buildings, and equipment required for such an institution to the value of 500,000*l.*, with the promise to secure other funds for both capital outlay and maintenance, provided that the council would express, in general terms, its willingness to contribute, when the buildings were equipped and ready to be opened, a sum of 20,000*l.* a year towards the maintenance of the educational work. In referring to these proposals in our issue of July 2 (p. 203), we pointed out the importance of coordinating the work of such an institute with that of the University of London, and expressed the opinion that the development of both was a national concern, and ought not to depend upon the contributions of the County Council. We are glad to see that the committee of the council appointed to consider the scheme regard substantial assistance from the State as an essential condition of support, and think the council should not lend any encouragement to the idea that the whole of the cost of maintenance could be provided from London sources. The following recommendations of the committee were adopted by the council at Tuesday's meeting:—(*a*) That the council expresses its high appreciation of the important proposal contained in Lord Rosebery's letter, and would cordially welcome the establishment of further provision in London for advanced technological teaching and research. (*b*) That the council, in response to the request contained in Lord Rosebery's letter, places on record its opinion that, when the land, buildings, and equipment for the proposed additional technological teaching and research are provided to a value of not less than 500,000*l.*, the council will be well advised to contribute, out of the moneys annually placed at its disposal under the Local Taxation (Customs and Excise) Act of 1890, a sum not exceeding 20,000*l.* per annum towards such part of the work as falls within the statutory definition of technical education, subject to the following conditions:—(1) That a scheme be prepared to the satisfaction of the council for the constitution of the governing body and the adequate representation of the council thereon; (2) that financial arrangements adequate to the whole maintenance of the proposed work are made to the satisfaction of the council; (3) that, in view of the national scope and utility of the proposed work, substantial contributions towards maintenance be made from funds of a national character; (4) that due provision be made in the scheme to prevent overlapping and secure coordination of the work already carried on by the university colleges, polytechnics, and other science and technological institutions, and the proper connection of the whole with the university; (5) that a sufficient number of scholarships, including free places, be placed at the disposal of the council; (6) that it be considered whether other counties and boroughs should not be invited to contribute towards the maintenance, receiving in return the right to send their picked scholars for instruction under the proposed scheme.

THE Board of Education have issued new regulations for the instruction and training of pupil teachers and students in training colleges. In a preface by Mr. Morant it is stated that the "regulations are intended to secure for the pupil teacher a more complete and continuous education, and to make the period of service in an elementary school a time of probation and training rather than of too early practice in teaching." Pupil teachers admitted on and after August 1, 1904, must not be under sixteen years of age, except in rural districts, where the limit will be fifteen. After August 1, 1905, pupil teachers will not be permitted to serve in a public elementary school more than half the time the school is open, and they will be required to receive half-time instruction in an approved pupil teacher centre throughout their engagement. The Board of Education desires to encourage plans for educating pupil teachers with other scholars, and urges local educational authorities to arrange, by means of an adequate scholarship system or otherwise, that all the best candidates for pupil teacherships, whether boys or girls, should receive a sound general education in a secondary school, with schoolfellows intended for other careers, before they commence service in any capacity in an elementary school. There is already in existence a number of well-equipped and well-staffed pupil teacher centres, the best of which have more than fulfilled the purpose for which they were originally recognised by the Board. The new regulations should assist in developing corporate school life in such centres, and also in improving other less satisfactory central classes; they mark a very decided step in advance, and show an exact appreciation of the shortcomings of the pupil teacher system as it has existed until now.

A SCHEME whereby pupils in schools in different parts of the Empire may be put in communication with one another, with the view of exchanging observations, specimens and ideas, has been drawn up by the League of the Empire, and promises to be of great educational value. The committee recommends that linked-schools and members should first exchange maps of their respective districts, and where possible, photographs or drawings of their houses, of the school house, grounds and surroundings. It is suggested that nature calendars should be kept, essays written on common trees or other plants, and notes made on the habits of birds or other animals, or on industrial processes or natural products in the neighbourhood of the schools—all with the view of exchanging them with schools in other parts. Personal observations are to be insisted upon, so that the descriptions will be twice blessed—those who make the observations by exercising the best of their faculties, and those who receive the results by gaining knowledge of natural conditions beyond their individual view. Specimens are also to be exchanged for school museums. Already there are nearly two thousand members in correspondence all over the Empire exchanging specimens and letters, and the number will doubtless be greatly increased. Particulars of the scheme may be obtained from Mrs. Ord Marshall, hon. secretary of the central committee, 11 Dartmouth Street, Victoria Street, London, S.W.

To prevent misunderstanding, Mr. C. McDermid, secretary of the Bessemer Memorial Fund, has issued a letter in which the relationship between the scheme for the Bessemer memorial and that put forward by Lord Rosebery is described. The persons responsible in each case have been in close consultation throughout, but the two schemes will continue for the present to be directed separately, though they will be controlled by joint trustees. For the purposes of the advanced metallurgical training and specialised research works which are to form the Bessemer memorial, it is proposed that London shall be regarded as the centre for the metallurgy of copper, silver, gold, &c., Sheffield as the centre for steel, and Birmingham as the centre for cast and wrought iron and alloys. It is intended that the post-graduate scholarships shall, in part, be international. It is hoped that the committee will be able to submit the complete scheme in October.

DR. W. SCHLICH, principal professor of forestry in the Royal Indian Engineering College, Coopers Hill, has been appointed honorary professor of forestry at the Royal Agricultural College, Cirencester. Mr. McClellan, jun., who was recently appointed professor of forestry and estates management at the college, has, during the past four months, been gaining experience of continental forestry, and with Dr. Schlich has made a six weeks' tour through specially interesting forest districts in Germany.

MR. H. W. RICHARDS has been appointed principal of the Brixton Technical Institute of the London Technical Education Board. The Board has made the following appointments in connection with the Paddington Technical

Institute:—Head of the chemical department, Dr. H. Reynolds; head of the physical department, Mr. J. H. Vincent.

THE following research fellowships and scholarships have been awarded by the executive committee of the Carnegie Trust for the universities of Scotland. *Research Fellowships.*—Chemical: Dr. C. E. Fawaitt, Dr. J. C. Irvine, Mr. W. Maitland. Biological: Dr. J. Cameron. Historical: Dr. D. Mackenzie. *Research Scholarships.*—Physical: Mr. J. H. MacLagan Wedderburn, Mr. H. W. Malcolm, Mr. J. R. Milne, Mr. T. B. Morley. Chemical: Mr. J. Knox, Mr. J. Johnston, Mr. F. J. Wilson. Biological: Mr. S. F. Ashby, Dr. R. T. Leiper, Mr. H. J. Watt.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 28.—"Researches on Tetanus." By Prof. Hans **Meyer** and Dr. F. **Ransom**.

The experiments were in the first place made with the object of finding an explanation for local tetanus. One of the earliest and most striking symptoms of tetanus in man is, as its popular name implies, stiffness of the masseter muscles (lockjaw); this is the case wherever the infected wound may be situated. In certain animals, however, as cats, dogs, and rabbits, when tetanus toxin is injected subcutaneously into a limb, the first symptom is a rigidity of the muscles of the injected member; this is known as local tetanus. Afterwards, if enough toxin has been given, the rigidity becomes general. An experimental explanation of this condition has hitherto been wanting.

The authors believe that their experiments prove conclusively that the course of events in experimental tetanus is as follows:—The toxin is taken up from the point of injection by the motor nerves (probably their naked endings). Passing along these it reaches first the corresponding motor centres in the spinal cord and excites there an over-irritability, so that the discharges which normally give rise to muscular tone become abnormally strong, and produce in the muscles of the injected limb the condition known as tetanic rigidity. The toxin also passes from the point of injection into the lymphatics and thence into the blood.[1] From the blood-lymph stream, if enough has been given, other motor nerve ends take up toxin, and general muscular rigidity ensues.

The authors show experimentally that the toxin only reaches the nervous centres by way of the motor nerves, and further, that the movement of the toxin in the nervous system does not take place in the lymphatics, but in the protoplasm of the nerves. Tetanus toxin never reaches the spinal centres along the sensory nerves, but, if it is injected into a posterior root, sensory disturbance is the result.

The greater part of what is known as the period of incubation, that is, the interval which elapses between the injection of toxin and the first symptom of intoxication, is the expression of the time occupied in the conveyance of the toxine from the periphery along the motor nerves to the susceptible centres.

Relying upon the results of their experiments, the authors are of opinion that the tetanus of warm-blooded animals consists of two processes, separated from each other both in time and space. Of these the one is primary, a motor intoxication, local muscular rigidity; the other, secondary, is a local sensory intoxication, a diffused reflex tetanus starting from the intoxicated neuron.

Repeated experiments showed that, when tetanus toxin was introduced direct into a motor nerve, antitoxin, though present in large quantities in the blood, was unable to prevent the outbreak of the disease, or even to hinder a fatal result. This was the case both when large doses of antitoxin were given before and after the toxin, as well as when an actively immunised animal was employed. The experimenters therefore conclude that injected antitoxin does not reach the substance of the nerve fibrils and centres, and that even with highly immunised animals the neurons remain free from antitoxin. As regards the serum treatment of tetanus, it is clear that in these circumstances any toxin which is already in the motor nerves, though not yet in spinal centres, will not be neutralised by antitoxin, whether injected under the skin or direct into the blood. An attack corresponding to the amount of toxin absorbed by the nerves will break out and run its course in spite of antitoxin. On the other hand, any toxin in the blood or lymph will be rendered harmless by an injection of antitoxin, and so a further intoxication will be prevented.

The authors have further made successful attempts to prevent the access of tetanus toxin along the motor nerve to the susceptible centres by injecting antitoxin into the nerve substance (ischiadicus), so, as it were, blocking the passage of the toxin.

Just before this paper was read, a case occurred at Marburg of a man who received an injury of the hand from the breaking of a flask of tetanus toxin. Antitoxin in large quantity was injected under the skin a quarter of an hour after the injury; nevertheless, after eight days, a local tetanus of the arm broke out. This was treated by injection of antitoxin into the nerve trunks of the affected limb, and the patient recovered. The occurrence of a local tetanus in spite of the large quantities of antitoxin, and the satisfactory result which followed, and perhaps was due to the injection of antitoxin into the motor nerves of the affected limb, show that the conveyance of the poison from periphery to centre takes place in men, as in animals, along the motor nerve, and affords, further, a valuable hint for the treatment of tetanus.

The full report of these experiments appears in *Archiv für experimentelle Pathologie und Pharmakologie*, Band xlix.

June 11.—"Observations on the Physiology of the Cerebral Cortex of the Anthropoid Apes." By Dr. A. S. F. **Grünbaum** and Prof. C. S. **Sherrington**, F.R.S.

June 18.—"Cyanogenesis in Plants. Part iii. Phaseolunatin; the Cyanogenetic Glucoside of *Phaseolus lunatus*." By Wyndham R. **Dunstan**, M.A., F.R.S., Director of the Imperial Institute, South Kensington, and T. A. **Henry**, D.Sc. Lond.

The poisonous seeds produced by partial cultivation in Mauritius of the plant *Phaseolus lunatus* have been examined and found to contain a cyanogenetic glucoside of the formula $C_{10}H_{17}O_6N$, to which the name *Phaseolunatin* has been given. The glucoside crystallises in colourless needles, and when acted upon by the enzyme emulsin, which is also present in the seeds, or by warm dilute acids, it is hydrolysed into *dextrose*, *acetone*, and *hydrocyanic acid*.

$$C_{10}H_{17}O_6N + H_2O = C_6H_{12}O_6 + CH_3.CO.CH_3 + HCN.$$

Alkalis convert the glucoside into *phaseolunatinic acid* ($C_{10}H_{18}O_8$), and this, by the further action of hot dilute acids, is hydrolysed into *dextrose* and *α-hydroxyisobutyric acid*. Phaseolunatin is therefore the *dextrose ether of acetonecyanhydrin* $(CH_3)_2 : C(CN).O.C_6H_{11}O_5$.

The seeds produced by *Phaseolus lunatus* vary in toxicity and in the colour of their seed-coats, depending upon the care bestowed on the cultivation of the plant. In Mauritius, where the plant is grown for use as a green manure, the seeds furnish, when moistened with water, from 0·041 to 0·088 per cent. of prussic acid, and possess dark brown or purple seed-coats; in India the seeds, which are imported into this country under the name of "Rangoon" or "Paigya" beans, and are used for the manufacture of cattle foods, are pink with purple spots, and yield only 0·004 per cent. of this acid, whilst the large, white Lima or duffin beans, produced by long-continued cultivation of the plant, yield no prussic acid, although they still contain the enzyme emulsin.

It is suggested that if hydrocyanic acid or its precursors—the cyanogenetic glucosides—in plants, may be regarded as formative materials utilised for the synthesis of proteids, then the absence of such glucosides from the cultivated seeds of *Phaseolus lunatus*, and from those of the cultivated almond, may be the result of more active metabolism induced by improved conditions of growth, so that no supplies of the glucoside are available for storage as reserve material in the seeds.

[1] Ransom, Hoppe Seyler's *Zeitschrift f physiol. Chemie*, Band xxix and xxxi.

Faraday Society, June 30.—Mr. J. Swinburne, vice-president, in the chair.—Mr. W. C. Dampier **Whetham**, F.R.S., gave an abstract of his paper on the present position of the theory of electrolysis. The fact that the products of electrolysis appear at the electrodes only led to the Grotthus chain hypothesis. Faraday's laws suggest opposite convective streams of anions and cations. Hittorf's observations on the unequal concentration of the solution lead to the conception either of complex ions, dragging along salt or solvent, or else unequal velocities of the ions the ratio of which can be measured. Kohlrausch's measurements of the resistance of electrolytes enable the absolute velocities to be measured. The fact that electric conduction in solutions obeys Ohm's law shows that the E.M.F. is merely directive, and that the ions have migratory freedom. The fact that ionic mobilities only vary slowly with dilution, while the conductivity of a dilute solution is proportional to the first power and not the cube of the concentration, shows that the ions must be free of the solute molecules—not necessarily of those of the solvent. The osmotic properties of electrolytes lead to the same conclusion. A short consideration of conduction in non-aqueous solution and in fused salts completes the paper.—Mr. **Swinburne** gave a short account of his paper on chlorine smelting, with electrolysis, an abstract of which we print elsewhere (p. 285).—A paper by Dr. R. A. **Lehfeldt**, on the total and free energy of the lead accumulator, was taken as read, and the discussion adjourned until the next meeting.—Dr. **Perkin** exhibited and explained several novel pieces of electrolytic apparatus devised by him for laboratory work.

PARIS.

Academy of Sciences, July 13.—M. Mascart in the chair—On the stability of a particular mode of flow of a sheet of water of infiltration, by M. J. **Boussinesq**.—On the torsional movements of the eye during the rotation of the head, by M. Yves **Delage**.—Remarks by M. Alfred **Picard** on the third volume of his "Rapport général sur l'Exposition universelle de 1900."—On the deformation of surfaces, by M. M. **Servant**.—On the measurement of coefficients of self-induction by means of the telephone, by M. R. **Dongier**. A special telephone invented by M. Mercadier was used in this work. It only reinforces sounds of a determined period, and remains insensible to the harmonics caused by capacity or by magnetic substances in the core of the bobbin. Measurements of self-induction of the order of 10^{-2} Henry were made with an accuracy of one-half per cent.—A combination of ferric sulphate with sulphuric acid, by M. A. **Recoura**. A ferrisulphuric acid has been isolated, possessing an analogous composition to the chromosulphuric acid previously described; unlike the latter, however, it is immediately decomposed by water.—On the action of carbon monoxide upon iron and its oxides, by M. Georges **Charpy**. Ferric oxide, heated in a current of carbon monoxide, is completely reduced to metallic iron, containing carbon, at all temperatures between 200° and 1200°, the velocity of reduction increasing with the temperature. Metallic iron takes up carbon at all temperatures between 560° and 1190° C., the metal remaining free from deposited carbon at temperatures above 750° C.—On the so-called colloidal silver, by M. **Hanriot**. The conclusion is drawn that the albuminoid material in collargol, the oxide of iron in the preparation of C. Lea, and the silica in the silicargol are not to be regarded as impurities, but as integral portions of the molecule, not only because it is impossible to separate them without destroying the colloidal silver, but also because these bodies have then lost their characteristic properties.—The action of hypophosphorous acid on diethylketone and on acetophenone, by M. C. **Marie**. Acids containing phosphorus have been obtained analogous in composition with acids derived from other ketones; the oxidation products are also similar.—On the chloride of phenylpropargylidene, $C_6H_5.C{:}C.CH.Cl_2$, by MM. Ernest **Charon** and Edgar **Dugoujon**. Phenylpropargylic aldehyde was treated with phosphorus pentachloride, and the chloride separated by fractional distillation. Its stability is greater than that of cinnamylidene chloride. The addition products with chlorine and bromine were isolated, and also proved to be very stable towards air and water.—The preparation of the secondary amides, by M. J. **Tarbouriech**. Two methods were used, the action of the acid on the corresponding nitrite, and the action of the acid chloride upon the primary amide; the latter gave better yields. The properties of dibutyramide, diisobutyramide, divaleramide, and diisovaleramide are described.—The action of ammonium persulphate upon metallic oxides, by MM. A. **Seyewetz** and P. **Trawitz**.—The action of bromine upon pinene in the presence of water, by MM. P. **Genvresse** and P. **Faivre**.—The influence of the nervous system on the ontogenesis of the limbs, by M. P. **Wintrebert**. From the experiments described the conclusion is drawn that the nervous system is not necessary in the production of the limb, neither for its growth, general morphogeny, nor for its differentiation.—The geographical distribution of the Coleoptera (Bostrychides) with respect to the food requirements of these insects, by M. P. **Lesne**.—On a lactic diastase capable of hydrolysing salol, by MM. A. **Miele** and V. **Willem**. The authors regard the existence in milk of a ferment capable of hydrolysing salol as doubtful.—On the modifications in respiration due to age, with especial reference to the guinea-pig, by M. Léopold **Mayer**.—On the variation of *Bornetina Corium* according to the nature of the medium, by MM. L. **Mangin** and P. **Viala**.—The influence of common salt on the transpiration and absorption of water in plants, by M. H. **Ricôme**.—On a bud graft on the lilac, by M. Lucien **Daniel**.—The presence of cordierite in the eruptive products from Mont Pelée and Mont Soufrière at St. Vincent, by M. A. **Lacroix**.—The origin of the folds in the Pyrenees, by M. Joseph **Roussel**.—Experimental researches on dreams. The relation between the depth of sleep and the nature of the dreams, by M. N. **Vaschide**. In light sleep the dreams have reference to things which occurred immediately preceding sleep, but in profound sleep the dreams have no reference to recent events.

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