THURSDAY, SEPTEMBER 23, 1897.

EXPERIMENTAL EMBRYOLOGY.

The Development of the Frog's Egg. By T. H. Morgan. Pp. x + 192. (New York: The Macmillan Company. London: Macmillan and Co., Ltd., 1897).

Ueber Verwachsungsversuche mit Amphibienlarven. Von Dr. G. Born. 8vo. Pp. xi + 224. (Leipzig: Wilhelm Engelmann, 1897).

THE theories of Roux and Weismann concerning the significance of nuclear division have been the cause of much useful work. The attempt to decide experimentally whether the early divisions of a fertilised egg are in fact accompanied by a qualitative separation of nuclear or other "determinant" material has led to the remarkable observations of Roux, Driesch and others upon the behaviour of isolated blastomeres, and upon the effect of destroying one or more blastomeres in a segmenting egg. Prof. Morgan has attempted to collect the results of such observations in a form convenient for students. His book contains a fairly full account of the maturation, fertilisation and cleavage of the Frog's egg, but the later stages of development are treated very briefly indeed, the main purpose of the work being a discussion of hypotheses such as those of Roux and Weismann in the light of recent experiment.

The difficulties in the way of a belief that the early divisions of the egg are accompanied by qualitative separation of "determinant" substances are largely increased by the demonstration that in any single blastomere, removed from the egg at a sufficiently early period, is capable of giving rise to an embryo which is not apparently abnormal except in point of size. Prof. Morgan devotes more than a third of his book to an account of the experiments which lead to this conclusion, and to the equally interesting experiments which show that under certain circumstances the first two blastomeres may remain in contact, and yet each of them may give rise to a separate individual. The book is provided with a useful bibliography.

Whatever be the process by which the result treated by Prof. Morgan is arrived at, there is no doubt that in many animals each of the early blastomeres can by proper treatment be made to produce an apparently complete larva, while at a later stage in development the removal of any group of cells involves the production of a defective individual. Prof. Born has undertaken an elaborate series of experiments in order to find out at what stage of development this change in the properties of embryonic tissues takes place. The first results of his work, recently published in the *Archiv für Entwicklungsmechanik*, are now reprinted as a separate volume.

Prof. Born has worked with the larvæ of Amphibia, and chiefly with *Rana esculenta* and *Bombinator igneus*, starting with unhatched larvæ shortly after the closure of the medullary groove. Such larvæ may be removed from their gelatinous cases for purposes of operation, and reared in "normal" salt solution until the proper hatching time, when they may be gradually transferred to fresh water. After treatment of this kind, many of Prof. Born's larvæ have metamorphosed into apparently healthy frogs.

The first results are an extension and confirmation of an old statement made by Vulpian, that the tail of a newly-hatched tadpole will continue to differentiate after being cut off from the body. The tail, cut away from an unhatched larva, and grown in salt solution, continues to exhibit histological differentiation and growth, with a very slight amount of "regenerative" formation of new tissue in front of the point of section. Dorsal and ventral fin, medullary tube, notochord, all the various organs proper to the excised tail differentiate in a nearly normal way, the principal abnormality due to the section being the closure of the nerve tube and the growth of a layer of ectoderm over the cut surface. The growth and differentiation seem to go on normally until the yolk contained in the tissues is used up, when the whole structure naturally dies of starvation. In the same way, the excised head will continue to grow and to differentiate until starvation occurs, without regenerating the hinder part of the body; the amount of differentiation which takes place before death being indicated by the statement that in the oldest heads a complete chondrocranium was formed. What is true of the head is true of segments cut out from the middle of the body: and as Prof. Born says:

> "Die Entwickelung jedes Organes, bis zur Schnittfläche, so gut wie bei der normalen Larve, fortschreitet, mag die Schnittfläche liegen, wie sie will. . . . Dabei ist noch Folgendes zu bemerken. Röhrenförmige Organe, wie Rückenmark, gehirn, Vornierengänge, ja sogar mitunter der Darm schlieszen sich an der Schnittfläche ab."

An obvious defect of these experiments is that they fail to show how far development would go, if a proper arrangement for feeding the excised tissues could be devised. Prof. Born has, therefore, made a larger and even more interesting series of experiments, by grafting pieces, taken from the bodies of one set of larvæ, into the bodies of others. For example, the excised hinder end of a larva is attached to the wound produced by slicing away a small piece of the ventral surface of a second larva. After a short time, the ectoderm of the "accessory" tail unites with that of the body of the "principal" tadpole, so that an unbroken ectoderm covers the whole; the nerve-tube of the "accessory" tail closes, and does not appear to develop a communication with the nervous system of the principal larva; the blood vessels of the stock anastomose freely with those of the graft, so that the grafted tail has an abundant food supply. In this way an organism is produced, possessing two tails, and perhaps two pairs of hind limbs. The rate of growth of the grafted tail, &c., may not be the same as that of the corresponding organs in the stock, so that one tail may after a short time be larger than the other; but the rate of histological differentiation is the same, so that if the limb of the graft (as in one case described) remain much smaller than that of the stock, it has not the structure of a limb at an earlier stage of development than that of the stock, but a reduced model of a limb at the same stage of differentiation. This synchronism in the histological differentiation is shown by Prof. Born to occur whenever two individuals (or parts of them) are so united as to have a common vascular system; and the connection which this result seems to suggest, of a direct relation between chemical change in the blood and histological differentiation in the tissues, opens up a promising field for further work.

The hind end of a larva, grafted in the manner described on to the body of a second larva, can be reared up to the time of metamorphosis. It seems to grow normally, up to the point of section, except that its rectum, if present, communicates with that of the stock. There is apparently little or no nervous connection between stock and graft, since gentle stimulation of the graft causes reflex movement only of that tail, the stock remaining quiescent, and *vice versâ*.

In a similar way an excised head, grafted into the ventral surface of a second larva, may remain without nervous connection with the stock. The two are connected chiefly through the œsophagus of the graft, which fuses with and opens into the alimentary canal of the stock, and by the blood vessels. Such a grafted head shows snapping and respiratory movements, which are independent of those performed by the head of the stock, and have a different rhythm. As before, the grafted head may be larger or smaller than the head of the stock, but the rate of histological differentiation is the same in both.

These experiments go to show that provided a proper food supply be furnished, any portion of a frog larva, after the closure of the medullary folds, will develop in very nearly the same way, whether it be in its normal relation to the rest of the embryo or not, up to the period of metamorphosis. Indeed, the death at metamorphosis appears at least in many cases to be simply caused by mechanical injury which the stock inflicts upon the graft, by scraping it against foreign bodies—a phenomenon obviously connected with the absence of nervous communication between the two. It is especially pointed out that the position of the grafted portion has no obvious influence on the result: so that nothing like the "polarity" observed by Wetzel in his experiments with Hydra, and by others in similar cases, can be seen in the larval frog.

The cases so far mentioned involve the union of comparatively small portions of one larva with the nearly complete body of a second. More complicated unions are effected by slicing a small piece from the ventral or from the dorsal surface of each of two larvæ, and joining the two by their wounded surfaces, so that two nearly complete larvæ are united. The relation between such components follows the same rule as that found to hold for the unions already described: the rate of growth may differ to a considerable extent, but the rate of histological differentiation is always the same. In these cases, and in those presently to be mentioned, corresponding organs, which are in contact at the point of section, unite; and hollow organs, such as gut, nervous system, heart, cœlom, unite in such a way that the cavity of one component communicates with the homologous cavity of the other. In ventral unions, therefore, the two components have a common alimentary cavity, a common cœlom, and often a common heart; in dorsal unions they have a common neural cavity, and so on. When corresponding organs unite, there is generally complete histological continuity of the characteristic tissue of the organ from one component to the other, without any formation of scar tissue, so that nerve fibres run across the line of junction of two brains; gastric epithelium evenly across the junction of two stomachs, and so on.

Detailed descriptions of many of these unions are given, but some of the most interesting are as yet withheld. Some of the results of these unions have been successfully reared through the metamorphosis, and are now frogs. The reasons which have prevented Prof. Born from killing these creatures in order to describe their structure will be easily understood.

A third series of specimens is obtained by uniting the front portion of one larva to the hinder portion of another; and where about each component contains about half a larva, the result seems to be almost indistinguishable from a normal individual. A case is described in which the anterior two-thirds of one larva was united with the posterior two-thirds of the other; the resultant creature has been reared through the metamorphosis, and is now a frog with a trunk of abnormal length.

The way in which corresponding organs unite across the plane of section in cases of this kind is truly remarkable, and induces a belief in some adjustment of the parts after apposition. For example, the pronephric ducts unite so that the cavity of the anterior portion of the duct communicates with that of the posterior portion; and in spite of the very wonderful manipulative skill which Prof. Born must have attained, it is difficult to believe that such minute structures can have been even frequently adjusted by him with absolute accuracy at the time of operation; indeed, in the case of the much larger spinal cord there are sometimes obvious indications of a readjustment.

The last series of experiments described demonstrates the possibility of obtaining some of the results by joining larvæ or portions of larvæ belonging to different species, or even to different genera. Unions are figured between *Rana esculenta* and *Bombinator igneus*.

The experiments are not yet concluded, and it would be presumptuous to do more than describe them; at the same time, their interest is so great that it has seemed worth while to do this at considerable length.

W. F. R. WELDON.

EFFECTS OF HIGH ALTITUDE UPON MAN.

La Cure d'Altitude. Par le Dr. Paul Regnard. Pp. viii + 436. 8vo. 29 plates; 110 figures in the text. (Paris: Masson et Cie., 1897.)

THE hardihood and endurance of mountaineers has been always celebrated. A Swiss Protestant clergyman, Kraenbühl, noticed a great difference between children from the mountains and those of certain schools in Zürich and Bern. He arranged for some of the weakly children from the towns to live at Beatenberg in the mountains, and after some months had the satisfaction of seeing these children much improved; in fact, completely changed for the better. This occurred about 1850, and attracted many delicate persons to

Beatenberg. The present reputation of Alpine health resorts is, therefore, of comparatively recent date, especially so their use as places of residence during winter, and any one visiting Davos to-day would hardly believe that it is only about thirty-two years back since the first invalids came there for their health.

The French employ Alpine health resorts much less than the English and Germans, and therefore Dr. Paul Regnard is all the more to be congratulated on the production of his capital book; it is written in the clear lucid style for which French scientific writers have become celebrated, and it gives us a satisfactory explanation of the principles on which the curative and exhilarating influences of residence in high altitudes depend. The author carries us over the scientific ground pleasantly enough, laying before us, in admirable order, the various observations of practitioners, and the experimental investigations which have been undertaken both in the mountains and in laboratories to explain the action of the phenomena observed. The result of all this work is that the use of mountain climates is no longer empirical, but rests on a well-established scientific basis.

One of the most interesting phenomena observed in human beings and animals, when removed to high altitudes, is the change which takes place in the quality of their blood; and on this subject the author is well qualified to speak, for much of the investigation concerning it has been carried out by his compatriots, and he himself has undertaken several original experiments to settle doubtful points.

Paul Bert discovered that the blood of animals living in high altitudes absorbed more oxygen than that of similar animals at ordinary elevations, and in this observation he was soon confirmed by Müntz, who removed rabbits from Tarbes to the Pic du Midi de Bigorre in the Pyrenees (2377 metres), where they remained close to the observatory on the summit of the mountain, and bred naturally. This was in 1883, and in 1890 Müntz compared the blood of rabbits born on the mountains with that of rabbits of the plain, and found that the former was richer in hæmoglobin, and absorbed more oxygen than the latter. Viault found that at high altitudes the red corpuscles of the blood increased rapidly in numbers, and out of proportion to the increase in hæmoglobin. The work was taken up by Egger and Mercier, of Arosa, and Prof. Miescher, of Bâle, and no doubt was left that the red blood corpuscles notably increased soon after residence in places of high altitude. Egger found that the hæmoglobin was likewise notably increased, but not relatively so much as the number of red corpuscles. When residents of the mountains descended to live in the plain, he found that the number of their red corpuscles fell to the normal. Mercier considered that the degree of increase in the number of corpuscles varied directly with the altitude. Sellier tried the effect on animals of an atmosphere abnormally rich in oxygen. His results were doubtful, but the carefully conducted experiments of Regnard himself seem to establish the fact that when animals are kept for a considerable time in an atmosphere containing too much oxygen, their red corpuscles decrease in number.

It is clear that Dr. Regnard assigns a great part of the effect of mountain resorts to the influence of the altitude on the blood. To illustrate his views, we may take the case of a consumptive person. By life in town and under other unhealthy influences, he has become anæmic and badly nourished; consequently his tissues are less able to withstand the tubercle bacillus, and he becomes infected. He then goes, we may suppose, to some Alpine resort, either directly, or after resting some time at an intermediate station. Owing to the diminished amount of oxygen in the air at high elevations his blood is not able to absorb enough for its proper requirements, and consequently a "reaction" gradually takes place. New "microcytes" are quickly formed, and these develop rapidly into full-sized red corpuscles, and gradually acquire the normal amount of hæmoglobin. Thus the blood becomes richer in red corpuscles and in hæmoglobin; it can absorb more oxygen, and the whole body is better nourished (though fat and comparatively useless material may be lost, so that there may in many cases be an actual decrease in body weight, at first at least), and offers greater resistance to the growth of the bacilli. When the patient descends to lower elevations the number of his red corpuscles slowly returns to the normal amount; the good effects on the general nutrition remain, and the blood, though not so rich in corpuscles and hæmoglobin as it was in the mountains, is of good quality and not below standard, as it probably was when the illness commenced.

Mountain sickness results, according to the author, from the diminished pressure of oxygen in the atmosphere, and its consequent diminution in the circulating blood, at a time, moreover, when on account of the muscular exertion of climbing it is especially needed. It is, in fact, due to asphyxia of the tissues. Prof. Clifford Allbutt and most authorities are practically now agreed that deprivation of oxygen is the essential cause of *mal des montagnes*.

The author believes that a comparative immunity from phthisical contagion is obtained at high altitudes in spite of the presence of phthisical patients and of the "contagium vivum," which the more careless of them scatter about with their expectoration. This he attributes partly to the excellent "sanguinification" of those resident in high altitudes, and their consequent resistance to the bacilli of tuberculosis, and partly to some antiseptic action of the climate which is capable of diminishing the number and virulence of these microbes outside the body.

Though he points out the charms of mountain resorts, Dr. Regnard is careful to speak of trials which sometimes await the visitor. It is in spring when the snow is melting, that the Mediterranean resorts triumph, but then succeeds the rapid growth of vegetation in the mountains, one of the most beautiful sights afforded by nature. The fogs which come with rainy weather cause a moist cold which may be very trying, and these are perhaps the chief drawbacks of the Alps. The dust of the roads at some localities are amongst the drawbacks which disappear during winter, when the ground is covered with ice and snow.

In the second part of the work, that chiefly devoted to an account of the individual resorts, Dr. Regnard is responsible for the new term "Hypsiatrie" (*i.e.* treatment by high altitudes). The localities described have been visited by the author, and views of many of them are given. We must note one drawback which the volume has, in common with most French books, namely, the absence of an index. F. P. W.

ELECTRO-METALLURGY.

Electric Smelting and Refining: the Extraction and Treatment of Metals by means of the Electric Current. Being the second edition of *Elektro-Metallurgie*, by Dr. W. Borchers. Translated, with additions, by Walter G. McMillan. Pp. xx + 416. With numerous illustrations. (London: C. Griffin and Co., Ltd., 1897.)

Though electro-metallurgy may still be regarded as in its infancy, it is such a lusty youngster and is making such rapid progress that it is high time that a good manual on the subject in the English language should be available to our engineers. No better work is wanted than a translation of Dr. Borchers' well-known treatise, and it has been excellently put into English by Mr. McMillan, who has also done his best to bring the work up to date, a task rendered all the easier by reason of the shortness of the time (considerably less than two years) that has elapsed since the publication of the German edition. The additional matter mainly concerns the practical aspect of the subject, accounts of actual applications of processes to which little or no reference is made in the German text being inserted under many of the subheads. With these additions, enough is stated to give a good general idea of the present industrial position of electro-metallurgy.

Little space is devoted to introductory matter, the author plunging into the thick of his subject almost at once. A short account, however, is given of the newer electro-chemical theories, but the student is referred for fuller explanations to the works of Ostwald and Nernst.

In Part i., which deals with the alkali and alkaline earth metals, the most interesting section is that on the carbides of calcium, strontium, and barium. The history of the subject is noticeable, as it differs somewhat from that given by M. Moissan in the *Annales de Chimie et de Physique* last year. Thus Dr. Borchers claims to have produced the carbide of calcium in his electric furnace as long ago as the year 1880, although no use was made of the discovery, which was not published until 1891, until "the later researches of Maquenne, Travers, and Moissan first recalled attention to this class of compounds" in 1892–94. It is remarkable that Moissan, writing at a later date than Borchers, does not refer to the experiments of the latter. The electric furnace used by Borchers differs from that employed by other experimenters in having a thin carbon pencil connecting two thick carbon cylinders. When the current is passed, the carbon pencil becomes intensely heated owing to the great resistance offered by it, and the charge, which is packed round it, is heated by contact. There is here no possibility of electrolytic action, and it is on the results obtained by the use of this furnace that the author, in 1891, based the law, which he claims to have established, that "all oxides are capable of being reduced by carbon if the temperature is sufficiently high"—a law which has not as yet obtained full recognition.

The most important parts of the book are, however, those dealing with aluminium and copper. In both these sections the historical accounts are particularly good, the progress of events in the electrolysis of fused compounds of aluminium, for example, being traced from the experiments of Davy in 1807 to the practical installation of the Hall process at Pittsburg, working details of which were not published until 1896. Many patent specifications are given and processes mentioned, some of them being admittedly impracticable, and even, in the author's opinion, absurd, for "we may learn something even from negative results." The good points in each and the causes of failure are carefully pointed out, with the result that the history is made most instructive. It is true that Dr. Borchers shows a pardonable tendency to praise what is German and to criticise and decry the work in the United States and elsewhere; but the translator has in part corrected the impression conveyed by this patriotic prejudice by the additions made in many parts of the book. It is disappointing that details are not forthcoming of the work of the British Aluminium Company, which we learn is now the largest producer of that metal in the world, using 2500 h.-p. at their Falls of Foyers works in Scotland; but it is, of course, not surprising that manufacturers, after spending thousands of pounds and much time over their experiments, should prefer to keep the results to themselves for a time.

The electrolytic refining of fairly pure metallic copper, like the direct reduction of aluminium from its oxide, is of special interest, because all the main difficulties have now been overcome, and a complete account can be furnished. Here again there is a slight tendency on the part of the author to regard the latest German process, the Siemens-Borchers system, as perfection, and to ignore the later American practice, in which a much higher current density is used, and the cost thus materially reduced, in spite of the fact that wages are higher than in Germany. Several exact descriptions of processes in works are given, however, illustrated by capital diagrams, and the whole section is of great value.

Passing to other metals, silver, gold, lead, tin, zinc, and antimony all receive adequate treatment, and an interesting description is given of the various processes of electric welding, local softening, and soldering of iron and steel.

Among minor errors that were noticed may be mentioned the statement on p. 239, that ores of silver and gold are never smelted with copper ores with the design of concentrating the precious metal in the copper. This method, however, has been in use for some time in New Mexico. Again, the melting-point of gold is given as 1035°, a figure long since abandoned, and some erroneous figures are given concerning the relative cost of the Siemens-Halske and other cyanide processes for the treatment of gold ores. Such trivial mistakes do not impair the value of the work, which must of necessity be acquired by every one interested in the subject who does not already possess the second German edition.

There is much material for reflection for engineers in England in the phenomenal rapidity with which the practical applications of electro-metallurgy are advancing in Germany and in America. The consideration, in particular, repeated in this volume over and over again, to the effect that too much attention can easily be paid to water-power, is well worth bearing in mind. That such power costs little or nothing is obviously far from being a fact, when one takes into account the cost of the plant and the rent of the waterfall, a rent that will tend to increase more and more as the owners of the ground realise its value. On the other hand, while water-power is sought high and low for electrical purposes, the waste gases from blast furnaces and coke ovens represent surplus energy, which passes away unused in many modern works, to the extent of hundreds, or even thousands, of horse-power units. There is here open, thinks Dr. Borchers, a field which can and will be at once successfully used by electro-metallurgy.

OUR BOOK SHELF.

The Mammoth Cave of Kentucky. An Illustrated Manual. By Horace C. Hovey, A.M., D.D., and R. Ellsworth Call, A.M., Ph.D. Pp. v + 110. (Louisville: John P. Morton and Co., 1897.)

NEARLY a century has passed since the wonderful Mammoth Cave of Kentucky was found by a hunter who entered it in pursuit of a wounded bear. The cave is one of many which occur in the limestone regions of Kentucky and other States of the Central West. It is stated by Dr. Hovey that there are as many as four thousand sink-holes—one covering an area of not less than two thousand acres—and five hundred known caverns, in Edmonson County alone. The Mammoth Cave is not the most interesting from a scientific point of view, nor is it so beautifully decorated with stalactites as the adjacent White Cave, but it transcends the others in the grandeur of its dimensions. So far as is at present known, there is only one entrance to the cave; from it two principal lines of exploration have been laid out, and they are both described in detail in the manual before us.

It is really refreshing to read a guide-book of the kind which Drs. Hovey and Call have given us. Instead of extravagant descriptions of the scenic features, and of imaginary resemblances found in stalactites and stalagmites, we have a fair amount of interesting information on the causes which produce such formations, and on the natural history of the cavern generally. In a section on the geological features of the cave we read (p. 96):

"The rocks which contain Mammoth Cave, and all the caverns surrounding it, are of Sub-carboniferous age. There are but two members of the Sub-carboniferous included in the vertical section, and they are the Chester Sandstone, which forms the immediate surface rock, of varying thickness, and the St. Louis Limestone, largely, in this section, oolitic, in which the great body of the cave is formed. Between these members, but not always present, is a variant layer of conglomerate, from which are derived most of the siliceous pebbles which are found in the floor of the cavern in certain places."

The fauna and flora of the cave are briefly described, and a list is given of the various forms of life which are certainly known to live in the cavern at the present time, the places where they are generally found being also described. Dr. Call has himself collected and studied the animals of the cavern, and has added a number of interesting forms to the list of those previously known. It is pointed out that, with the exception of the blind-fish (*Amblyopsis spelæus*), which was described by Dr. De Kay in 1842, the earliest descriptions of animals from the Mammoth Cave were by Europeans. Two blind beetles, one blind spider, and a blind crayfish were first described by Dr. Tellkampf in 1844.

A map of the cave is appended to the volume, and a number of pleasing plates illustrate various parts and formations. The authors are familiar with every part of the cave, and their scientific training enables them to see and understand more of the nature of things than an untrained observer. We could not desire a better guide-book to the subterranean wonderland of Kentucky than the one they have produced.

The Survival of the Unlike: a Collection of Evolution Essays suggested by the Study of Domestic Plants. By L. H. Bailey. Pp. 515. (London: Macmillan and Co., Ltd., 1896.)

THE book before us consists of a number of addresses delivered during a period extending over several years. They are of unequal merit, but nevertheless are all well worth reading,and some of them are remarkable both for their vigour and the stimulating interest of their contents.

To the evolutionist there is much food for reflection. As Dr. Bailey truly says, the evolution of species is going on all around us, and nowhere can the process be more readily followed than in the case of cultivated plants. He emphasises the extraordinary amount of diversity to be seen within the limits of a species, and indeed even in the different branches of the same tree, and he shows pretty conclusively that in the case of apples, for example, different types which are characteristic for certain regions, may be traced back with certainty to a single parent form. This is of special interest as proving that new races may arise by a process of selection within the limits of vegetative (not seminal) propagation. In fact the author himself goes so far as to say that "there is no essential difference between bud-varieties and seed-varieties, apart from the mere fact of their unlike derivation; and the causes of variation in the one case are the same as those in the other." Further, "that much of the evolution of the vegetable kingdom is accomplished by wholly sexless means." There is no doubt, however, that although we may sometimes hesitate to follow him in his conclusions, Prof. Bailey's arguments merit attention, and will have to be reckoned with. He has a terse and epigrammatic way of driving home his meaning which is refreshing, and he really strikes a note of needed warning in saying, "I sometimes think that we are substituting for the philosophy of observation a philosophy of definitions."

Extremely interesting are the pages devoted to the evolution of some of our vegetables, flowers, and fruits, and, amongst the latter, mention may be specially made of the tomato and the strawberry.

Altogether the book may be commended to a wide circle of readers. It is clear in style as well as forcible in diction, and its author has made good use of a wide range of facts from sources which are not, to every one, readily accessible.

The Eye as an Aid in General Diagnosis: a Handbook for the Use of Students and General Practitioners. By E. H. Linnell, M.D. Pp. 248. (Philadelphia: The Edwards and Docker Company, 1897.)

THE general fact that a person's state of health may be judged from the expression of the eye is well known. In the book before us Dr. Linnell shows that every tissue of the eye at times affords points of diagnostic importance. As he points out, "Examination of the eyes affords valuable aid not only in the diagnosis of diseases of the central nervous system, but also of constitutional affections and diseases of other organs." It is to obtain a wider recognition of the relations of diseases of the eye to general diseases, and to place before the student and family physician the experience of a specialist as to the eye symptoms which are valuable in diagnosis, that this book has been written. The volume will doubtless prove a serviceable handbook of diagnosis to the general practitioner.

The Chlorination Process. By E. B. Wilson, E.M. Pp. iv + 125. (New York: John Wiley and Sons. London: Chapman and Hall, Ltd., 1897.)

THIS little volume bears a strong family resemblance to the book on "Cyanide Processes," by the same author, which has already been reviewed in NATURE. An engineer who has not studied chemistry so much as other subjects naturally encounters difficulties in describing a "wet" or so-called chemical process. For example, on p. 61, the equation representing the formation of gold chloride in cases where bleaching powder is used is given as follows:

$$Au + CaOCl_3 + H_2SO_4 = AuCl_3 + CaSO_4 + H_2O.$$

It is stated further on that "the chlorination process is based upon this reaction." If such opinions are not counted, there is not much that is new in the volume.

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.*]

African Language.

IN an exceedingly interesting article in your issue of the 16th, on "Anthropology *versus* Etymology," I am so much struck by the clear statement of the old school mythologist dogma, that "the old name of a deity which had lost its meaning might remind a later generation of the name of some beast; hence might arise those stories of gods taking the forms of beasts," &c. That this is really the case among certain West African tribes I am quite certain, and I believe that, as far as West Africa goes, the confusion caused in white minds by the language has given rise to a good deal that has been said regarding the West African natives believing themselves descendants of animals. It is, I need hardly say, no uncommon thing to find one and the same word used for two or more distinct things. When that word is written down by a white man, who may not notice the accompanying gesture, that marks in which relation it is employed, error is liable to creep in, and you may be calling "slowness in walking" "the new leaves on trees," or *vice versâ*, or "a hundred bundles of bikei" "the butt-end of a log," or, "a finger-snap" "your maternal aunt" among the Bafanh. This also shows as an element of the danger of judging from words alone in the case of the name used by all the Fjort tribe, *who are under the Nkissi school of fetish*, for their great over-lord of gods, *Nzambi Mpungu*. In the Loango and Kacongo districts *Mpungu* means a great ape, and the word is used there also as the name for this great god, the creating god; hence it would be easy, and I hope excusable, for I did it at first myself, to think the great god and the ape had some connection. Nevertheless, they have not Nzambi Mpungu as a name, for the great deity was imported into the Kacongo and Loango from a region on the south bank of the Congo, with the rest of the Nkissi cult, prior to the discovery of these regions by Diego Caõ; and therefore, when the word is used in a religious sense, it bears the religious meaning which it brought from its original home, namely, *something that is above*, or *that covers over*. Mr. R. E. Dennett tells me that Mpungu is used in this sense to this day in the Nlanoi dialects.

The truth is, we are now urgently in need of a Prof. Max Müller for African languages. When attempting to grasp the underlying idea of witch-doctors' methods at Okiyon (among true negroes, I found an alarming state of affairs connected with the so-called word *woka*. The only thing I can liken *woka* to is a nest of spiders, which as soon as you touch it with a stick ceases to be a manageable affair; in *woka* there are representations of at least three sets of opinions bearing on the interrelationships of matter and spirit. I subsequently found ample reason to believe that this was the case with all secret society words; namely, that they were words the full meaning of which were only known to the initiated. The ordinary free man or woman passing through the ordinary course of secret society instruction would only learn the signification of a simple set of them. The full meaning of the strong words are only known to the few men at the head of the society. Having grasped this state of affairs I decided to stick to fishing and the land law, hoping that this mystery was confined to the *strong mouth*; but a few months ago, I having requested Mr. Dennett, of Loango, to send up some of the interesting stories I knew were prevalent among the Fjort tribe, among whom he has lived for seventeen years continuously, he sent me what he calls "the key to the Fjort alphabet," which shows me this strange figurative unworked-at thing lays behind the whole of that language. I have no hesitation in saying Mr. Dennett's MS. is a most appalling work, and it produces great irritation in most patient anthropologists promptly; and what we now require, as aforesaid, is that Max Müller who will give the student of the African great assistance, and then we will hope some great philosopher will come and enable us to have anthropology *cum* etymology and any other ology that will help us to know the whole truth.

M. H. KINGSLEY.

100 Addison Road, Kensington, W., September 19.

On Augury from Combat of Shell-fish.

IN your issue of May 13 (p. 30), Mr. Kumagusu Minakata quotes several examples of augury from the combat of shell-fish. In Spencer St. John's "Life in the Forests of the Far East," vol. i. p. 77, amongst various ordeals related by him as being practised by the Sea-Dyaks of Sarawak, he gives the following:—"Another is with two land shells, which are put on a plate and lime-juice squeezed upon them, and the one that moved first shows the guilt or innocence of the owner, according as they have settled previously whether motion or rest is to prove the case."

CHAS. A. SILBERRAD.

Etawah, N.W.P., India, August 21.

THE MEUDON ASTROPHYSICAL OBSERVATORY.[1]

THE foundation of this national observatory may be said to date from the time of the return of the French expedition which was sent to Japan to observe the transit of Venus in the year 1874. Since that period the observatory has been content to publish many of the important results of work completed in various journals, chiefly in the *Comptes rendus*, but it is only quite recently that the first of a series of "Annals" has appeared. It is this volume which we propose now to pass under review; but we may preface our remarks by reminding the reader that many of the sections inserted are not published here for the first time, especially those relating to the photography of solar surface details.

M. Janssen opens with a most interesting historical introduction, which sums up the steps which led to the present efficient state of this national observatory, the line of work which has been actively pursued since its foundation, and the instrumental equipment which it now possesses. Neither does he forget to refer to the important *rôle* played by M. Cezanne, an eminent engineer and the principal originator of the French Alpine Club, in proposing and strongly advocating, before a meeting of the National Assembly, the necessity of establishing, near Paris, an observatory for the pursuit of physical astronomy. The suggestion was in due course submitted to the Academy of Sciences, and the committee appointed to inquire into it thoroughly endorsed the advisability of the scheme. It was pointed out that such an institution was not only useful, but necessary and urgent; that the part taken by France in these new studies, their importance, and the novelty of the methods on which they were founded, made them a new and distinct branch of astronomy, and called for a special establishment, where they could be freely cultivated. Strengthened by the discovery of spectrum analysis and photography, physical astronomy became a branch of astronomy of sufficient importance to be pursued with success and developed by itself.

The necessity for the establishment of the institution being thus strongly stated, it was not long before an observatory was provisionally installed at the Boulevard

[1] "Annales de l'Observatoire d'Astronomie Physique de Paris," par J. Janssen. Tome I. (Paris: Gauthier-Villars et Fils, 1896.)

d'Ornano, the place where the Japan expedition had been prepared. The question then arose as to the location of the permanent observatory, there being two available buildings belonging to the Government which could be utilised for this purpose—one at Malmaison and another at Meudon. The latter was finally settled upon, and the partial restoration of the old château in the grounds was commenced on lines suitable for the work to be undertaken.

The most satisfactory manner in which the whole of this undertaking has been completed, will have been noticed by those who have had the opportunity of visiting this charming spot. Those less fortunate may gather a good idea from an examination of the excellent series of heliogravures which form part of this volume. The old château, with its spacious grounds and rooms, has proved suitable in many ways for such a physical observatory. The large instruments have been housed in appropriate domes, while the rooms devoted to researches of several kinds have proved most convenient.

Before referring to the work accomplished, let us briefly make a survey of the instrumental equipment. The large equatorial consists of a twin-telescope with apertures of 0·83 and 0·62 metres, the latter being devoted to photography. These objectives have practically the same focal length, being 16·16 and 15·90 metres respectively. They are set up together on the same mounting, and housed under the large dome situated in the middle, but at the upper part, of the main building. The dome itself is 18·50 metres in diameter, and is rotated by means of electricity, the same motive power being also used for elevating or depressing the observing platform. Two other smaller domes of 7·50 metres diameter, situated in the grounds, contain respectively a Newtonian reflector of 1 metre aperture and a refractor of 0·30 metres aperture. The former has a focal length of 3 metres and was made by the brothers Henry, M. Gautier having undertaken the mechanical parts. This reflector is mounted somewhat after the English system, and is, as Prof. Janssen states, a "précieux instrument de voyage." The solar photographic telescope is described as being of fine optical perfection, and is due to Prazmowski. This instrument will, however, be referred to later on, so we may pass on to those parts of the building set apart for laboratory work.

In restoring the old château, as many of the smaller buildings about it were retained as were likely to prove serviceable on a future occasion. Such, for instance, was the case with the old stables, which measured nearly 100 metres in length, and could be easily extended another 40 metres if thought desirable. These have since been appropriated for a large physical laboratory, and the oak partitions have been preserved in their original positions, serving among other things as useful supports for the long tubes, which are employed in the investigation of gases under pressure. The accompanying illustration (Fig. 1) gives a good general view of this long corridor, and shows how the sides of the horse-boxes have been utilised; three of the long metal tubes can be seen resting on the partitions, and lying along the corridor a considerable distance. These tubes measure 60 metres in length, their diameters being about 0·05 metres. They are joined in sections of 6 metres, and so securely is this accomplished, that for more than six months a pressure of from 20 to 30 atmospheres has been maintained without any sensible leakage. Among the investigations carried on here may be mentioned the determination of the densities and spectra of gases under high pressures.

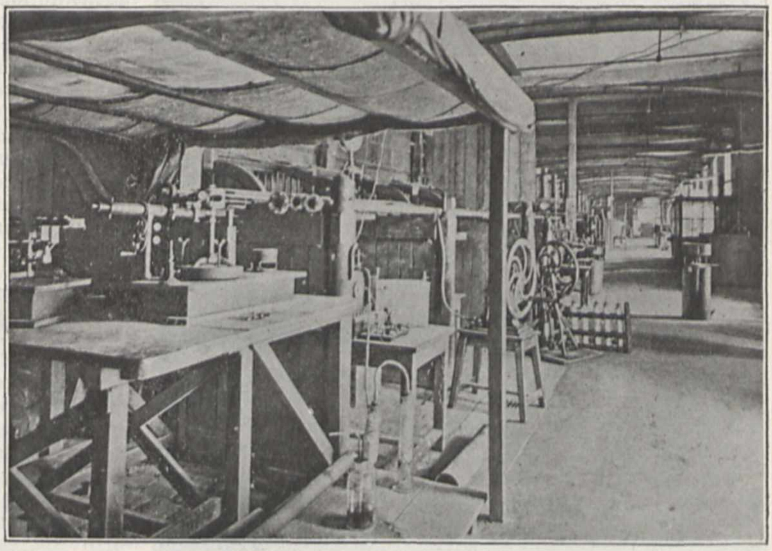

FIG. 1.—The Meudon Stables as an Astrophysical Laboratory.

Coming now to that portion dealing with solar photography, this is of special interest in that the methods and results of a long series of researches are given in a somewhat detailed form. Solar photography at Meudon has attained such a high state of perfection at the present day, that this may be looked upon as one of the chief fruits of the observatory; in fact, quite a new era in this branch of the subject has dawned.

To describe the steps which have led M. Janssen to achieve such a high state of excellence in photographing minute details would necessitate a longer account than we can here afford; we must restrict ourselves, therefore, to the main lines on which success has followed so quickly and so surely.

Investigations on the optical properties of the material to be used for the lens as regards photographic absorption, showed that the glass gave a maximum amount of light very confined in the violet region of the spectrum near the Fraunhofer line G. A study of the sensitiveness of the photographic film was next undertaken, and a film was finally produced which was most active for those rays which M. Janssen desired to employ. The objective was then made so that the images formed at the focus were nearly exclusively composed of rays of the same refrangibility; they were also, as M. Janssen states, extraordinarily sharp. The next point was to produce as fine a grain as possible in the film, and of sufficient delicacy to reproduce all the details of the image exposed on it. The results of these experiments, giving the actual proportions which were finally adopted, are described at some length. It is interesting to note that great stress is laid on the importance of rigorously cleaning the plate in the first instance We read "cette propreté est ici encore plus indispensable que pour les photographies artistiques les plus soignées." Other points of difficulty successfully overcome were: considerable magnification of the image to show the delicate details of the solar surface, and to diminish the effects of irradiation; complete control of the shutter, to ensure sufficient exposure and exemption from irradiation; and, lastly, means of equally exposing all parts of the image.

The photographs obtained by employing the above-mentioned instrument and method were, as a rule, of 0·30 metres diameter, but for special purposes diameters of 0·50 and 0·70 have been used. Some of these pictures have been beautifully reproduced in the volume before us, and surpass any others that have been obtained both in clearness and fineness of detail.

A minute examination of such photographs has greatly enlightened us on many points regarding the surface movement and appearance of the photosphere, and in the near future we shall have series of photographs taken very quickly one after another, which will help us to follow the motions, invisible even to the unaided eye, most closely.

Further, it has been shown that the forms, dimensions, and distribution of the granulations are not in accordance with the ideas formed of these elements of the photosphere as seen through telescopes. The photographic images do not confirm the notion that the photosphere is built up of elements, the forms of which are constant, and resemble rice grains, &c. The granulations, according to M. Janssen, assume different shapes under different circumstances, and vary very much in size.

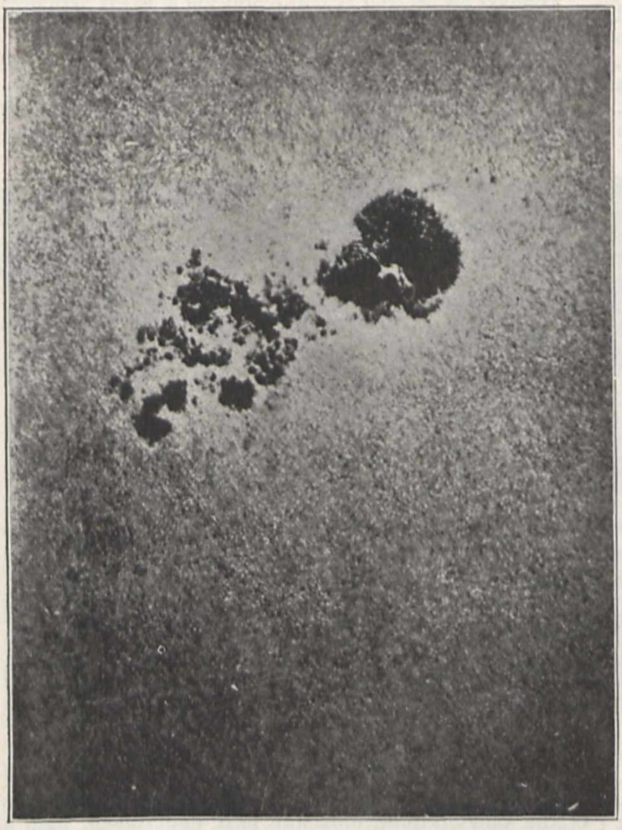

FIG. 2.—A portion of the solar surface, showing a sunspot and a mean *réseau* (June 22, 1885).

The discovery of the photospheric *réseau* is another outcome of the Meudon photographs. A close study of the photographs showed that the photosphere was not uniformly constituted in every part, but that it was divided into series of figures more or less separate from one another, and exhibiting a peculiar structure. The sizes of these figures were found to vary, and their contours were more or less rounded, sometimes rectilinear, and very often polygonal. These different types of *réseaux* are clearly seen on the photographs in the volume, and one of these, illustrating a mean type of *réseau*, is given in the reproduction accompanying this article (Fig. 2).

The picture, here considerably reduced, was taken on June 22, 1885, the diameter of the disc being 0·888 metres, and gives a good idea of what is meant by a mean *réseau*. The photograph shows, further, a large spot, the principal nucleus of which measured nearly two minutes of arc in diameter. The faculæ and striæ of the penumbra of the spot illustrate very clearly that these parts were formed of granulations like the rest of the solar surface.

A special inquiry as to the distribution of this granulation over the entire solar surface brought out the fact that even at the poles it was quite distinguishable; it thus differs from the spots, which are limited to two narrow belts on each side of the solar equator.

The last sections of the volume are devoted to several other uses of solar photography, as, for instance, the questions of the presence of a lunar atmosphere, or of small bodies passing between the earth and the sun. Both of these have been investigated at Meudon, and in each case a negative answer was the outcome of the research.

In bringing this notice to a conclusion, we may remark that this, the first volume of the "Annals," is worthy of the institution from which it hails, besides being a valuable contribution to astronomy. It is, perhaps, the most handsome volume of any "Annals" which it has been our lot to notice, and the numerous reproductions of photographs are models of what can be accomplished in this line of work.

The French Government is to be congratulated on being the means by which such fine work in astronomical science can be accomplished, and is, we have no doubt, proud of the able director to whose energy and skill such important advances are due.

WILLIAM J. S. LOCKYER.

RECENT WORK OF THE UNITED STATES GEOLOGICAL SURVEY.

THE Fifteenth Annual Report of the United States Geological Survey opens with a few words of farewell spoken by the Director, Major Powell, on his retirement. Modestly and briefly he reviews some of the work done by himself and his colleagues, which has been expressed in not less than a thousand maps and two hundred volumes. The last Report issued by him is a worthy successor of the earlier ones in material and in illustrations; many of the latter are exceptionally fine, and show what can be done by the artistic printing on high-class paper of blocks processed from good photographs. When will English officialdom learn that the thousands of pounds spent in promoting research lose nine-tenths of their effect on account of the slovenly and imperfect presentation of the results to the public?

One of the most interesting memoirs in this volume, on the Granites of Central Maryland, is prefaced by a short but very able chapter from the pen of Prof. G. H. Williams, whose promising life has been cut off in its prime. Here we see evidence of a firm grasp of his subject, with knowledge and experience amongst the class of rocks with which he deals, and the ability not only to acquire and assimilate the work of other observers, but to show clearly that towards the end attained not only himself but a host of other workers have contributed.

Evidence from apophyses, chilled margins, contact metamorphism, and inclusions, as well as from the ultimate chemical and mineralogical constitution of the rocks, is all effectually used to demonstrate that these rocks are igneous products; the close association of a wide range of petrographic types is evidence pointing to the same conclusion. The pegmatites are studied in detail, and a conclusion arrived at that in this district segregative and intrusive types are mixed together. This preliminary study is followed up by Prof. Williams' student, Mr. C. R. Keyes, in a detailed description of the binary or true granites, granitites, and hornblende-granites of Maryland. This writer insists that both primary and secondary muscovite occur in the granites, and that the intimate intergrowths of allanite and orthite are original and not secondary products. The bed-like or "sheeted" and spheroidal joints are described and illustrated, and it is made quite clear that the rocks are of igneous origin, locally affected by shearing, so as to pass into gneissose and schistose rocks.

Mr. Lawson's paper on the Geology of the San Francisco Peninsula is deserving of attention at the present time, when cherts and other radiolarian rocks are being so much studied in Britain. Mesozoic rocks, the Franciscan series, rest unconformably on the Montara granite, which, in its turn, is intrusive into crystalline limestone. The Franciscan series consists of sandstones, in the interstital matter of which important reconstruction has occurred, foraminiferal limestones, radiolarian cherts, and volcanic rocks, partly intrusive and partly interbedded, and often exhibiting characters similar to the "pillow lavas" which occur in Britain in association with cherts. The latter rocks, which range from holocrystalline aggregates of quartz granules to masses of isotropic silica, are well banded and associated with what the author calls shales, although "the highest powers of the microscope fail to reveal any clastic material" in them, and he is driven to admit that it is only the interbedding of the cherts with common sandstone which checks the supposition that they are deep-sea deposits. He inclines to the view that the silica has been mainly derived from submarine, siliceous springs. The rocks of this series, where associated with intrusive peridotites, pass into micaceous, chloritic, and amphibolic schists. An excerpt from some notes of Dr. Hinde shows that he has compared the radiolaria with forms from Jurassic and Cretaceous rocks in Switzerland and Hungary. A short account of the serpentines, the later bedded rocks, the diastrophic record, and geomorphy concludes the memoir.

The preliminary report on the Marquette iron-bearing district of Michigan, while illustrating the use of local names in accurately defining particular terranes, certainly makes one wish that such of the terms as are likely to become of larger importance were less cacophonous. The Wewe slate, the Ajibik quartzite, the Bijiki and Kitchi schist, of this paper, the Rappahannock and Aquia Creek series of another paper, suggest a large field of work for the International Congress in the special effort at simplification of nomenclature which it is making at St. Petersburg. The basement series of granites and gneisses is separated by an unconformity from the lower Marquette, and that by another from the upper Marquette series, all these systems being folded together in a complicated fashion which has not yet been unravelled. The two Marquette series are correlated with the upper and lower Huronian systems. The bulk of the iron ores, which consist of specular iron and magnetite, occur in the Negaunee formation of the lower series, and below the Goodrich quartzite; but they frequently extend above and much more often below, into the numerous beds overlapped by quartzite. They have been formed by the concentration of iron ore in a cherty carbonate of iron, governed by the folding of the rocks and the position of intrusive diorite dykes.

Mr. Lester F. Ward contributes a memoir on the Potomac formation to the fifteenth report, and a correlation paper on its analogies to the lower Cretaceous rocks of Europe to the sixteenth report. The general order of succession is studied, and the floras dealt with in detail by the help of tables, plates, and descriptions of new species. The tables lead the author to conclude that the floras compare with the Kome and Atane beds of Greenland, and comprise the interval between these two. The correlation paper is accompanied by beautiful colour-printed geological maps of of South-east England and the Isle of Wight, the author considering that the Potomac formation is about equivalent to the Wealden series. Further comparison is instituted with Cretaceous floras in Italy, and Cretaceous and Jurassic floras in Portugal.

Under Mr. Walcott's direction the publications of the Survey at once become more specialised. One large volume is devoted to purely scientific work, two parts of another to mineral statistics and related papers, and a third to memoirs mainly of an economical character. This has led to a development in the character of the papers. Those of an economic character tend to become more useful to the agriculturist, the miner, and the road-master, while the rest are written in such a way as to be not only of value to the scientific man and popular for the public, but to have an educational character, being evidently written with a view of placing new ideas and methods of work before both official geologists and amateurs. As an example of the latter, we may cite the pre-Cambrian paper, by Mr. Van Hise; of the former, those on road-stones, by Prof. Shaler, and the mining papers in the economic volume.

In dealing with road-metal, Prof. Shaler shows that the tests of crushing strength usually made in Britain and elsewhere, while of great value for building stones, do not express all that is required with regard to material for roads. Bits of stone are placed in a drum, which is overturned at the rate of $33\frac{1}{3}$ revolutions per minute, and the powder is collected and weighed. The binding power of the dust is further tested by making briquettes, which are broken and then crushed, moulded, and broken again as often as necessary. This gives a fair idea of the staying power of any particular stone for different kinds of traffic, and enables the geologist, after further petrographical examination, to express a pretty decisive opinion on the merits of different metalling stones. Study of sections of roads shows that great attention ought to be paid to the gradual building up of metal, and that in many cases it would be advisable to mix softer binding stone with tougher metals on which the steam-roller has little crushing effect. An account of road metals and paving clays in Massachusetts is given in the sixteenth report, and of the United States generally in the fifteenth.

A very valuable report on the Cripple Creek mining district is given by Mr. Whitman Cross and Mr. Penrose, the former dealing with the general geology, the latter with the mining geology. Through a platform of granites and schists a volcano opened in Tertiary times, and ejected at first andesites and then phonolites, basalts, and rhyolites in an order which cannot be precisely ascertained, owing to the removal of lava streams by denudation leaving only dyke rocks behind. A sentence in the introduction shows that scientific terms taken into ordinary use suffer an even worse fate than ordinary terms which have been adopted for scientific use. In England the term granite, and in Ireland diorite, are used as almost synonymous with road-metal, the former being applied to everything from basalts to greywackes, and from porphyroids to hard sandstones. Similarly the word porphyry, originally meaning a purple rock, was first applied to a purple rock with "porphyritic" crystals in it, then to a ground mass like that embedding the crystals, whether the latter were present or not. Now, Mr. Van Hise quotes a miner's definition that "porphyry—well, porphyry generally runs three or four dollars" of gold to the ton.

The phonolites, which are intimately connected with gold deposits, are fully described; they contain abundance of felspar, nepheline, sodalite, ægirine, and a blue amphibole. Nepheline- and augite-syenite, nepheline-basalt, and tuffs and breccias also occur. The acid and intermediate rocks are rich in alkalies, and the latter eruptions were of strongly-contrasted acid and basic magmas, conforming to the complementary types of Brögger. In the mining portion of the memoir Mr. Penrose shows that gold occurs deep down as a telluride which has been decomposed near the surface to form native gold. The ore deposits occur in fissures, blending into the country rock, and generally associated very definitely with dykes, because fissures have followed pre-existing dykes. Detailed descriptions of the country, with maps and sections, follow.

Mr. Eldridge's geological reconnaissance across Idaho gives a brief description of Archæan and Algonkian rocks, which are overlain by Palæozoic rocks whose exact age is unknown, but apparently ranging from Cambrian upwards, and including sub-Carboniferous rocks. Cainozoic rocks follow, and igneous rocks of all ages from Archæan to Tertiary are present. Several mining districts, yielding gold and silver, are described, and a little coal occurs in the Tertiary rocks.

The Mercur mining district in Utah, described by Mr. Spurr, with an introduction by Mr. S. F. Emmons, yields both gold and silver, the latter chiefly at the contact of limestone with porphyry, where both rocks are altered and decomposed, the former where the Eagle Hill porphyry has produced a silicification of the limestone with which it is in contact. The ores are associated with sulphides, or else have become oxidized near the surface, and the gold probably occurred originally as a telluride.

The economic volume closes with two papers, one on the public lands and their water supply, by Mr. F. H. Newell, and the other on the water resources of the great plains, by Mr. R. Hay. The first paper indicates the rate of progress in disposal of public lands, their general agricultural character, and chief sources of water supply from streams, wells, and reservoirs. The second shows that, although the deep supply of water is limited, quite sufficient for probable requirements may be obtained from the Tertiary grit, which is met with at depths ranging from 100 to over 300 feet.

The two parts of vol. iii. of the Sixteenth Annual Report are entirely devoted to mineral statistics and papers germane to the mining industries. These statistics, previously published as ordinary octavo, are now issued in royal octavo, and form a part of the Annual Report. The production of minerals is represented not only by tables, but by curves and diagrams, so that their meaning can be rapidly grasped, and with them are published not only accounts of the various mining industries of the United States, but notices showing the history and present phase of the same industries all over the world. Mode of occurrence of the various classes of ores, methods of winning them, details of quarrying and mining operations, and prices of products are all treated in detail. Improved methods, whether adopted at home or abroad, are described in full, and every effort is made to bring all the industries abreast, or to keep them ahead, of what is done elsewhere. Many of the papers are compact summaries of particular classes of deposits, which will be extremely useful for those who require to become rapidly acquainted with particular products and industries. As examples of this, the articles on bauxite and fertilisers may be noticed. The article on iron contains a very useful set of maps, showing the localities of iron ore deposits throughout the world. Many of the other articles contain series of analyses, and bibliographies are annexed to some of the papers.

The scientific volume (Part i.) of the Sixteenth Annual Report opens with a short and, to some extent, popular paper on the dinosaurs of North America, by Prof. O. C. Marsh, illustrated by eighty-five plates, indicating the principal structural characters of these reptiles, and giving restorations where they are warranted by the number of bones preserved. The plates were prepared for a series of monographs now in preparation, and they are here published in advance. Questions of classification are relegated to a subordinate position, and the author confines himself almost entirely to a short account of the principal bones found, laying stress on the points which justify the restorations adopted. A useful table showing the horizons of vertebrate fossils in America is given, and in this the beds are classified according to their dominant vertebrate fossils, which, in the Mesozoic rocks, are chiefly reptiles. It is shown that the so-called "bird tracks" of Connecticut River are due to dinosaurian reptiles, and not to birds.

On comparing European with American Sauropoda, Prof. Marsh notes the absence of the gigantic Atlantosauridæ and the Diplodocidæ from Europe, while the Cardiodontidæ are abundant there. Restorations of four European forms—*Compsognathus*, *Scelidosaurus*, *Hypsilophodon*, and *Iguanodon*—are published, and, in conclusion, the affinities and classification of the dinosaurs are discussed.

Prof. H. F. Reid contributes a short memoir on Glacier Bay and its glaciers, like those named after Muir, Rendu, and Cushing, illustrated by an admirable series of photographs and profiles of the ends of the ice streams. After dealing with the "hard" geology, the stratified gravels are considered; these rest on blue clay formed of stream and moraine mud, covered with the tree stumps of a forest which appears to have been living within a few centuries until destroyed by floods and gravel. Certain smooth holes in the ice are thought to be the result of the closing of crevasses containing water by the ice-movement. An esker of sand and gravel, projecting one hundred yards from the moraine of Dent Glacier, has a winding course, and appears to have been produced by a stream flowing in a channel through the ice.

Part i. of the Sixteenth Annual Report closes with three very important papers by Nelson Dale, Van Hise, and Hoskins, dealing with a group of cognate subjects. Mr. Dale gives a series of examples of various structural phenomena which are well illustrated in the Green Mountain region and in eastern New York. Different types of folds, false-bedding, single, double and triple cleavage, and evidences of stretching and brecciation. This short paper is illustrated by drawings and photographs of sections and specimens, many of which are referred to by Van Hise in the communication which follows.

Mr. Van Hise, in his "Principles of North American pre-Cambrian Geology," gives, first of all, a set of principles to guide field-work in these rocks, weaving together the results of his own rich experience with the work of other observers, such as Heim, Lapworth, Rogers, Gilbert, Dana, Geikie, Harker, and a host of others. This is followed by an application of the principles to the different areas where pre-Cambrian rocks may be studied in America.

At a greater depth than 10,000 to 12,000 metres cavities could not exist, even in the strongest rocks, and all fissures and cracks would be closed and welded by flowage of the rock material under the stress existing there. Near the surface deformation of rocks by fracture would be possible, and between the two zones there would exist an area of combined fracture and flowage, the strong rocks yielding by the former, and the weaker by the latter process. Folds are simple or composite if in two dimensions, complex if in three; and it is pointed out that the true succession can only be made out in a complex district by unravelling the cross sets of folds, or, what is the same thing, ascertaining the "pitch" of the axes of the minor folds. The structures hitherto considered under the name of cleavage are separated into two types; that formed in the zone of flowage at right angles to the stress, and due to the growth of new particles and the orientation of old ones in this direction, thus giving rise to a grain in the rock, receives the name of *cleavage* proper; that which is due to definite planes of parting, formed along surfaces of shear, and originating in the zone of fracture, is called *fissility*. Those rocks, which on coming to the surface from the lower zone pass through the upper while under sufficient pressure to produce fissility, have this structure produced in the planes of true cleavage, while in other rocks it arises independently of any other structures. In deep-lying rocks fissility parallel to the bedding may be produced when the vertical weight is sufficient. Cracking and deposit of minerals may cause banded structures in imitation of bedding, and the imitation may be strengthened by further movement in the banded rock and by metamorphism.

The origin of joints and faults is somewhat lightly discussed. It is shown that both structures may result from pressure or tension, and Daubrée's explanation of joints by torsion is shown to be but another statement of their origin by complex folding. A very important point is made in linking these structures together and showing their relation to fissility, and it is insisted that "there is every gradation between faulting and fissility, and probably every gradation between faulting and cleavage."

Autoclastic rocks, crush-conglomerates and breccias, are next discussed, and it is pointed out how essential it is to discriminate between them and basement conglomerates. Metamorphism, in a wide sense, is next dealt with under the heads of consolidation, welding, cementation, injection, metasomatism, and mashing (dynamic metamorphism). The origin of the chief metamorphic rocks, both sedimentary and igneous, is fully discussed. In dealing with the most ancient sedimentary rocks, unconformities are of the greatest value, in spite of the undeniable difficulty of finding them; other tests of age are dates of intrusion and of movement, and number of movements undergone by different members of a succession. It must here be noted, however, that as the brain of a crow is unable to count more than three men with guns, so the brain of the geologist is inadequate to count more than three directions of movement, if so many. In igneous rocks the order of injection is still to be regarded as the great clue.

The pre-Cambrian rocks are divided into two great groups—the basement complex, or Archæan group, and the pre-Cambrian sediments, or Algonkian group. The different views held as to the origin of the first group are fully and fairly discussed, and after rejection of the theories that they are altered sediments, intrusive rocks, and primitive earth-crust, the view is provisionally adopted that, while little is probably left of the primitive earth-crust on which the Algonkian rocks were formed, it having been destroyed by erosion, the Archæan rocks represent the plutonic rocks solidifying beneath it, their formation in the upper part beginning in Archæan times and continuing steadfastly downwards to the present day. All the intrusions of those later-formed rocks, which have made their way to the surface through the upper (Archæan) layer, must be separated from it and considered as of later date. In dealing with the Algonkian rocks, a useful reference is given to all the fossils hitherto found in these rocks below the *Olenellus* zone, which is taken as the base of the Cambrian. The later part of Mr. Van Hise's paper will be found to be a most useful summary of the present state of knowledge of the American pre-Cambrian rocks.

The appendix to this paper contains a mathematical discussion of the depth of the zone of flowage, and the function of stress and strain on the rocks in producing cleavage and fissility.

NOTES.

THE following despatch from the Government of India to Lord George Hamilton is published in the latest number of the *Kew Bulletin*:—"We are informed by our Director of the Botanical Survey of India that the 'Flora of British India,' which was begun by Sir Joseph Hooker some twenty-five years ago, has just been brought by him to completion. The value of the work as a contribution to pure science has already been appreciated and acknowledged by others who are more competent to speak in such a matter than ourselves. But we desire to express our hearty recognition of the service to India which Sir Joseph Hooker has rendered by his monumental undertaking. He has for the first time brought the botany of the Empire into a collective form and placed it upon a firm and lasting basis, thus completing the work which he began nearly half a century ago in the Himalayas. We would ask your lordship to convey to Sir Joseph Hooker our high appreciation of his labours, and of their value and importance as systematising and adding to our knowledge of the vegetable productions of India, and our hearty congratulations upon having brought to a satisfactory conclusion a work to which he has devoted so many years of his life." In transmitting a copy of this letter to Sir Joseph Hooker, Sir Arthur Godley writes:—"Lord George Hamilton desires heartily to associate himself with the Government of India in their acknowledgment of the valuable services you have done to India by this great work, and by your labour in the field of Indian botany, since you first visited that country nearly fifty years ago."

WITH reference to the foregoing note, we learn from the *Kew Bulletin* that Sir J. D. Hooker's literary activity has not ceased with the completion of the "Flora of British India," which has occupied him for a quarter of a century. The veteran botanist has offered to undertake the preparation of the two remaining volumes of the "Handbook to the Flora of Ceylon," left unwritten by the untimely death of Dr. Trimen. The necessary materials and specimens have already been received at Kew from the Royal Botanic Garden, Peradeniya.

THE St. John's correspondent of the *Times* states that Lieut. Peary, the Arctic explorer, has returned from Greenland, bringing the Cape York meteorite, weighing forty-five tons, the largest in the world, and also six Arctic Eskimos, who are going polewards with him next summer. All the members of the expedition are well.

THE Commission du Musée d'Histoire naturelle at Geneva has formed itself into a committee having for its object the erection of a monument to the memory of François Jules Pictet-de la Rive. A site for the monument has been granted in front of the museum. Old students of the eminent investigator, and all who are interested in the work which he accomplished, are invited to send subscriptions for the memorial fund to MM. Lombard, Odier & Cie, Genève.

DR. T. W. ENGELMANN, professor of physiology in the University of Utrecht, has been appointed successor to the late Prof. Du Bois-Reymond in the chair of Physiology at Berlin.

PROF. WIESNER, of Vienna, has undertaken during the past summer a journey to Spitsbergen to complete his observations, previously made in the Tropics, as to the effect of light and other external conditions on the growth of plants.

AN International Ornithological Congress will be opened at Aix on November 9.

IT is reported that earthquake shocks were felt at Tashkent on Saturday last, September 18. The disturbance was noticeable over the whole of Turkestan, including Kasalinsk, Petrovsk, and Alexandrovsk. At Tashkent, Samarkand, and Ura-tiube several monuments of antiquity were damaged. A shock of earthquake, accompanied by a rumbling sound and the falling of rocks from the mountains, is also reported from the cantons of Grisons and Glarus, Switzerland.—A very severe shock of earthquake was experienced at Lima, Peru, on Monday, September 20. The cornices of churches and houses fell, and the walls were cracked.—At two o'clock on Tuesday afternoon, September 21, two shocks of earthquake were felt at Rome and in other places in Italy, including Rimini, Fermo, Recanati, Bologna, Sinigaglia, Fabriano, Cagli, and Florence. The shocks were also felt at Venice and Trieste.

FROM an obituary notice in the *British Medical Journal* (September 18) we derive the following particulars of the scientific career of the late Dr. A. F. Holmgren, whose death we have already announced:—Holmgren was born at Asen, in Linköpings Stift, on October 22, 1831, so that at his death he was almost sixty-six years of age. He studied at Upsala, and then became a teacher of natural science in a school. He graduated as M.D. in Upsala in 1861, and in the following year was commissioned to spend some years abroad to study physiology as it was taught by the great European masters. He studied under Ludwig at Vienna, and under Brücke, du Bois Reymond, and Helmholtz; while he also visited the schools of Paris, London, and Italy. In 1864 he was elected professor of physiology in Upsala, and built there the first physiological institute in Sweden. His scientific work ranges over a wide field, including his researches on the Negative Variation of the Muscle Current (1862), a similar condition in the active heart (1864); the action of poisons, calabar bean, chloroform, and atropine; the use of the ophthalmometer, and studies in colour sensation. Perhaps his best-known works are those on Retinal Currents. He showed the electrical currents of the retina, and how they are influenced by light, not only white light, but also the action of the various parts of the spectrum. He also showed that the electrical variation caused by light depends upon the retina only, and is not due to changes in the pigment, nor to the action of light on other constituents of the eyeball. His attention was in the early seventies directed to colour blindness, and in 1878 he published his well-known work on "Colour Blindness in relation to Railways and the Navy," thus bringing to a practical issue the work long before begun by George Wilson of Edinburgh (1855). This led him to the invention of his now well-known "worsted test" for colour vision. In 1889 he founded and became the editor of the *Skandanavisches Archiv für Physiologie*, as he says in the preface, "not only to unite our scattered forces under one flag," but to gain a powerful impulse for the advancement of the science in the north of Europe. He elected to publish all papers in German rather than Swedish for obvious reasons. To the last, optical studies were his favourite pursuit, and in 1891–92 we have a long paper in his *Archiv* "On Elementary Colour Sensation." All who were present at the Liège and Berne meetings of the Physiological Congress will remember Holmgren's genial presence, his stately eloquence, and his *bonhomie*. By universal consent he was perennial President of the Congress, and few who saw him two years ago would have thought that he would be so soon removed from his sphere of activity.

THE expectations of the inventor of the *Bazin* roller-boat as to the high rate of speed to be obtained with steamers without increase of engine power, owing to the diminution in frictional resistance of the wheels or rollers on which it was proposed to support the vessels, have not been realised. Accounts of this boat appeared in NATURE some months ago (vol. lv. pp. 109, 379). Since then the machinery has been completed and trials made on the Seine, which have shown that the action of the rollers does not decrease the frictional resistance of the water in the manner anticipated by the inventor, the adherence of the water to the surface of the wheels as they revolve acting as a brake and checking the forward movement of the vessel.

A NEW process for producing artificial diamonds has been experimented on successfully by Dr. Quirino Majorana (*Rendiconti della R. Accademia dei Lincei*). The present method consists fundamentally in heating a piece of carbon by the electric arc, and then submitting it to a violent pressure by means of a small plunger actuated by a piston, on which a pressure of 5000 atmospheres was suddenly developed by explosion. When a sufficiently strong cylinder had been constructed to withstand this enormous pressure, the experiment produced a black mass consisting largely of graphite and amorphous carbon. On employing Berthelot's method to isolate the diamonds if they existed, small microscopic crystals were obtained, mostly black and opaque, but which exhibited all the properties of true diamonds, notably in their manner of burning at a high temperature. The conclusion drawn from these experiments is that pressure and heat are alone sufficient to transform amorphous carbon into the crystalline or diamond form, and that the presence of a metallic solvent, as in Moissan's experiments, is not essential to the transformation.

AN optical device for the intensification of photographic pictures is described by Lord Rayleigh in the *Philosophical Magazine* for September. Photographers often obtain negatives which are so thin that intensification by chemical processes is insufficient to bring out any effective contrast between the transparent and opaque parts. The method devised by Lord Rayleigh is purely a physical one, and it may be described as a means of using a weak negative twice over. It is well known that by placing a feeble transparency upon a sheet of white paper, the picture becomes clearly visible, even though nothing can be seen when the transparency is viewed by holding it up to the light. Through the transparent parts the paper is seen with but little loss of brilliancy, while the opaque parts act, as it were, twice over, once before the light reaches the paper, and once again after reflection on its way to the eye. This is the principle of Lord Rayleigh's method. Instead of the paper, a flat polished reflector is used, the film side of the negative being placed in close contact with it. On the other side of the negative, and fairly close to it, is a condensing lens, which gives parallelism to the rays from the candle used as a source of illumination. The candle is placed just alongside of the copying lens; the light from it passes through the condensing lens, and falls as a parallel beam upon the negative. After reflection, the light again traverses the lens, and forms an image of the candle centred upon the photographic copying lens. An optically intensified positive is thus obtained, and by copying it in the same way in the camera, a negative with more pronounced contrast than the original may be made. To obtain satisfactory results, the false light reflected by the optical surfaces employed must be eliminated. In the case of the condensing lens the difficulty is overcome by giving the lens a slight slope with reference to the face of the negative. The false light reflected from the glass face of the negative to be copied may be got rid of by fixing a wedge-shaped glass plate to the glass side of the negative by means of fluid turpentine.

A DESCRIPTIVE list of mammals obtained from Somaliland by the East African Expedition of the Field Columbian Museum has been prepared by Mr. D. G. Elliot, and is now published in the Zoological Series of the Museum's publications. The expedition was sent to Africa to procure for the Museum specimens of the large wild animals which are rapidly becoming extinct. It appears to have been "uncommonly successful in obtaining ample series of nearly all the species inhabiting the country it traversed." Grace for the sin of killing animals which ought to be preserved may, perhaps, be found in the remark that "many more examples of the different species could easily have been procured, but after what was considered to be a sufficient number had been secured no more were killed, no matter how often the animals were encountered." The notes upon the characteristics and habits of the animals in life are very interesting.

IN previous numbers we have reproduced records of the Calcutta earthquake-pulsations of last June, obtained by means of the bifilar pendulum at Edinburgh and Cancani's seismometrograph at Rocca di Papa near Rome. Another fine diagram, made by the Vicentini microseismograph at Padua, is given in a paper by Dr. M. Baratta in the *Bollettino* of the Italian Geographical Society. The movement in both components began at 11.17 a.m. (Greenwich mean time), the pendular oscillations soon becoming very great. These lasted until about 11.35, but they were evidently superposed on long slow undulations, for the traces made by the pens are not symmetrical with respect to their normal positions. After 11.40 these undulations, which had a period of about twenty seconds, were isolated, and are unusually well marked, especially between 11.45 and 11.50. They are clearly visible on the diagram until 1·30 p.m., and, with the aid of a lens, for some time afterwards; so that, in consequence of this shock, the ground in Italy must have oscillated for about four hours.

THE kiss in Europe and China is the subject of a short paper by M. Paul d'Enjoy (*Bull. Soc. d'Anthrop.*, 1897, viii. p. 181). Originally, he says, the European kiss was a bite and a suction, the Mongolian being the act of smelling. The whites express to the person embraced that they would eat him or her with great pleasure; the yellows declare that the smell is that of an agreeable prey, either of nutrition or love. Whether from hunger or the sexual appetite, the two kinds of kissing have their origin, according to this author, in the instinct of the preservation of the race.

THE precommercial age, which was a very early stage in human culture, is exemplified at the present day, according to Letourneau (*Bull. Soc. d'Anthrop.*, 1897, viii. p. 152), by the Fuegans and Australians. The Eskimo, owing to contact with Redskins and Europeans, have, like the Veddahs of Ceylon, just passed beyond this stage. The Eskimo of Kamtchatka trade with the Russians, as do the Veddahs with the Cinghalese, by depôts, and avoid all direct communication.

THE lumbar curve of the vertebral column has been studied by Cunningham and by Turner, but very little information concerning this feature among the American races was forthcoming till a recent paper by Dr. G. A. Dorsey in the *Bulletin of the Essex Institute*, Salem, Mass. (vol. xxvii. p. 53). The mean index of eight varied American peoples ranges between 100·3 and 101·5; they are thus orthorachic. Dorsey considers the lumbar index as an important means of determining sex in any individual race or tribe, and that it bids fair to become one of the most valuable ethnic tests known in determining the physical superiority or inferiority of any tribe or race.

WE have received a letter from Mr. Saville-Kent with reference to the short article in NATURE of September 9 (p. 455) on the successful rearing of lobster larvæ by Mr. J. T. Cunningham. Mr. Saville-Kent points out that more than twenty years ago, in 1875, he was fortunate in rearing a number of these crustaceans from the egg to the final or ambulatory stage. A paper embodying the results of his experiments was communicated to the Conferences held in connection with the Great International Fisheries Exhibition in 1883, and it appears with accompanying illustrations in the official publications issued in connection with that Exhibition. We have referred Mr. Saville-Kent's letter, and the paper containing the results of his experiments, to Mr. Cunningham, who writes:—"I very much regret that in forwarding to you the facts concerning my experiments in lobster rearing at Falmouth, I overlooked Mr. Saville-Kent's previous success in the same practical problem. Although I had a vague recollection of having heard that he had made experiments of this kind, I had never seen any description of them, and I certainly did not think that he had succeeded in rearing the larvæ through the whole of their metamorphosis. Mr. Saville-Kent's paper, which I have now had the pleasure of seeing for the first time, was not in the library of the Plymouth Laboratory, at least I never saw it there, although I was fairly familiar with the contents of that library."

FROM the *Proceedings of the Chemical and Metallurgical Society of South Africa* for July last, it appears that, after many fruitless attempts, the treatment of stamp battery slimes from gold ores has now been mastered, and is steadily going on in several works in South Africa. Formerly the excessively finely crushed portion of the battery tailings, amounting to some 30 per cent. of the whole, was perforce allowed to run to waste, though theoretically worth nearly 1*l*. per ton. The slimes are now agglomerated and precipitated from the water in which they are suspended by the addition of lime water, and are then treated by agitation with very dilute solutions of cyanide (containing 0·01 per cent. or less of available KCy), and washed by settling and decantation, the gold being deposited by electrolytic action under the Siemens-Halske system. This process has been running for over twelve months at the Crown Reef Works, and is now costing about 3*s*. 9*d*. per ton, including royalty and management. The extraction is 83 per cent., and the net profit about 10*s*. per ton, or 50*l*. per day. The freshly-formed slimes in course of treatment at these works yield their gold to cyanide readily enough; but it is otherwise with accumulated slimes, in which oxidation of the pyrites has taken place. Here the presence of finely-divided ferrous sulphide and hydrate absolutely prevents the dissolution of the gold by withdrawing the free oxygen from the solution. Mr. W. Caldecott has discovered that by the supply of oxygen artificially this difficulty is cheaply and effectively overcome, and that jets of air, moreover, form the best means of agitation. Potassium permanganate is also used as an oxidiser. The oxidation and destruction of cyanide by air, long regarded as preventing its use for agitating cyanide solutions and promoting their solvent action, is not excessive in presence of ferrous sulphide, when the solution contains only from 0·005 to 0·008 per cent. of cyanide, or about 2 ounces per ton, an amount which, small as it is, is enough for the solution of the gold.

AN account of the range, cultivation, uses and products of the Camphor tree (*Cinnamomum camphora*) is given in a circular (No. 12) just distributed by the U.S. Department of Agriculture (Division of Botany). Notwithstanding the comparatively narrow limits of its natural environment, the camphor tree grows well in cultivation under widely different conditions. It has become abundantly naturalised in Madagascar. It flourishes at Buenos Ayres. It thrives in Egypt, in the Canary Islands, in south-eastern France, and in the San Joaquin Valley in California, where the summers are hot and dry. Large trees, at least two hundred years old, are growing in the temple courts at Tokyo, where they are subject to a winter of seventy to eighty nights of frost, with an occasional minimum temperature as low as 12° to 16° F. The conditions for really successful cultivation appear to be a minimum winter temperature not below 20° F., 50 inches or more oi rain during the warm growing season, and an abundance of plant food, rich in nitrogen. In the native forests in Formosa, Fukien, and Japan camphor is distilled almost exclusively from the wood of the trunks, roots, and larger branches. The work is performed by hand labour, and the methods employed seem rather crude. The camphor trees are felled, and the trunk, larger limbs, and sometimes the roots, are cut into chips, which are placed in a wooden tub about 40 inches high and 20 inches in diameter at the base, tapering towards the top like an old-fashioned churn. The tub has a tight-fitting cover, which may be removed to put in the chips. A bamboo tube extends from near the top of the tub into the condenser. This consists of two wooden tubs of different sizes, the larger one right side up, kept about two-thirds full of water from a continuous stream which runs out of a hole in one side. The smaller one is inverted with its edges below the water, forming an air-tight chamber. This air chamber is kept cool by the water falling on the top and running down over the sides. The upper part of the air chamber is sometimes filled with clean rice straw, on which the camphor crystallises, while the oil drips down and collects on the surface of the water. In some cases the camphor and oil are allowed to collect together on the surface of the water, and are afterwards separated by filtration through rice straw or by pressure. About twelve hours are required for distilling a tubful by this method. Then the chips are removed and dried for use in the furnace, and a new charge is put in. At the same time the camphor and oil are removed from the condenser. By this method 20 to 40 pounds of chips are required for one pound of crude camphor.

DR. WILHELM HALBFASS contributes to *Petermann's Mittheilungen* the results of observations on eight of the Eifelmaare. Elaborate contour maps are given, and a series of records of temperature and transparency. All the lakes are practically circular, the bottom steepest near the edges. The Laachen See is by far the largest, while the Pulver-Maar is the deepest lake in Germany outside the Alps, attaining a depth of 74 metres.

A PHENOLOGICAL map of parts of the coast regions of Albania and Epirus, by Dr. A. Baldacci, of Bologna, appears in *Petermann's Mittheilungen* (vol. xliii. 7), with part of a paper by the same author describing the physical geography and climate of the district in relation to its flora. The special interest of the region lies in the transition from the Mediterranean to the Alpine-Arctic flora direct, without the necessary interposition of the usual coniferous belt.

DR. A. PHILIPPSON publishes in the *Verhandlungen der Gesellschaft für Erdkunde zu Berlin* a short account of a cruise amongst the Greek islands of the Ægean during 1896. A number of geological observations were made, and are plotted on a sketch map, forming a distinct contribution to our meagre knowledge of this interesting region. The distribution of the masses of crystalline rock and the arrangement of the lines of faulting, call for thorough exploration.

TWO important contributions to the literature of historical geography have recently been published in Germany. The *Zeitschrift der Gesellschaft für Erdkunde zu Berlin* (vol. xxxii. No. 2) contains a paper, by Dr. Konrad Kretschmer, on a Catalan map in the Biblioteca Estense at Modena of date 1375, with a reduced facsimile of the map appended. These Spanish maps are of the greatest interest to geographers, particularly on account of the commercial relations existing at that time between Italy and southern France and north-eastern Spain. Only fourteen have hitherto been known, and of these only three are accessible in facsimile: that here reproduced and elaborately discussed by Dr. Kretschmer forms the fifteenth, and is the first known Catalan circular map of the world. Nos. 5 and 6 of the present volume of the *Mittheilungen der k. k. Geographischen Gesellschaft* of Vienna contain an abstract of a Festschrift published in commemoration of the opening of the sea route to India by Vasco de Gama, being a translation of parts of the Mohît of the Turkish admiral, Seidî 'Ali, with reproductions of some of the maps. The translation is by Dr. Maxim Bittner, Privat-docent in Oriental languages in the University of Vienna, and there is an introduction by Prof. Tomaschek. The Mohît is practically a book of sailing directions compiled, by the best sailor Turkey ever had, about the year 1554. Two chapters and part of a third dealing with topographical matters were translated by Prof. Luigi Bonelli and published in 1894; and the present paper covers much the same ground, with improvements and additions derived from the one of the two existing manuscripts which is deposited in Vienna. Translations of other parts of the Mohît into English, by Joseph Baron von Hammer-Purgstall, were published in the *Journal of the Asiatic Society of Bengal* between the years 1834-38.

THE College of Agriculture at Tokyo is doing excellent experimental work, judging by the contents of the latest *Bulletins* it has issued. In that of June last are several interesting memoirs, amongst which we may mention "Contributions to the Chemistry of Saké Brewing," by J. Okumura, in which attention is directed to the loss of starch which takes place in the process of washing the rice before it is steamed for saké brewing, whilst some valuable observations are recorded on the enzyme of the *Koji* fungus (*Aspergillus oryzæ*). K. Yabe contributes a paper on the origin of the saké-yeast, in which he points out once more that the *Aspergillus oryzæ* is quite incapable of yielding the saké-yeast cells. K. Negami details the results of his experiments on the fermentation of a grape wine with the saké-yeast cells, which do not, however, encourage the use of the latter for this purpose, the taste of the fermented product being that of an average white wine, the *bouquet* being, moreover, of an inferior quality. A highly suggestive memoir, full of experimental observations, is contributed by U. Suzuki, entitled "On an important function of leaves." The author comes to the conclusion, as the result of his investigations, that reserve proteids in the leaves are decomposed into amido-compounds during the night, and the latter are transported from the leaves to the other parts of the plants. The leaves facilitate the formation of proteids in all parts of the plants by the assimilation of nitrates, yielding thereby amido-compounds. A great advantage is thus gained for the stems, roots and fruits, in which the conditions for nitrate assimilation are less favourable than in the leaves. The May *Bulletin* of the College is entirely devoted to a long memoir, by H. Tokishige, "On the nature of Japanese Farcy, an Enzootic Skin Disease of the Horses and Cattle of Japan."

INVESTIGATIONS carried out at the Purdue University Agricultural Experiment Station in 1895, demonstrated that an efficient preventive of potato scab (a parasitic disease) is obtained by treating the seed tubers with corrosive sublimate. The poisonous and corrosive nature of this compound renders the treatment objectionable to some extent, so investigations have been made with the idea of discovering a preventive having the good qualities of corrosive sublimate without its bad ones, and which could confidently be used as the standard fungicide for potato scab. According to a bulletin just received from the Agricultural Experiment Station referred to above, this substance is formalin, the germicidal action of which was discovered by Loew in 1888. Observations made at the station lead to the following conclusions:—Formalin, a non-poisonous, non-corrosive substance, will practically free seed potatoes from scab germs by an immersion for two hours in a solution of the approximate strength of 1 : 300. It is equal to corrosive sublimate in efficiency, and is without its dangerous and troublesome properties. Seed material of seemingly good quality, as well as that much affected with scab, shows beneficial results from treatment. The recipe for its use is to add eight fluid ounces (about one half-pint) of formalin to fifteen gallons of water, and soak the seed tubers in it for two hours before planting. This solution may be used several times.

A FOURTH edition of the skeleton guide to the Royal Gardens, Kew, is now on sale at the Gardens. It has been carefully revised so as to include all recent improvements, and the size has been somewhat reduced to make it more convenient for the pocket.

A BATCH of the *Bulletins of Miscellaneous Information* of the Royal Gardens, Kew, Nos. 122-129, just received, contains many articles of scientific and practical interest. Under the name *Rhizopus necans* sp.n., Mr. G. Massee describes and figures a parasitic fungus exceedingly destructive to lily bulbs in Japan. It appears, however, not to attack uninjured bulbs, but gains an entrance only through wounds, more especially through broken roots. Attention is called to the importance of the cultivation in India of the papaw-tree, *Carica papaya*, from the value of the papain or "vegetable pepsin," which abounds in the unripe fruit. An interesting feature of the work done at Kew has been a compilation of the cryptogamic flora of the Gardens. Mr. G. Massee has been entrusted with the mycological department of the work, and now contributes a list of the fungi collected in the Gardens, numbering 337 genera and 1340 species, probably far surpassing in point of numbers, as well as in the variety of rare and interesting species, the mycological flora of any other area of equal size. The remarkable fact, however, is mentioned that not a single species of parasitic fungus that has proved destructive to plants, has been introduced to Europe through Kew. A list of the "Myxogastres" is also appended. From some notes contributed by the Director, it would appear that all questions respecting the botanical origin of myrrh are not yet settled, especially with regard to Somali myrrh; and travellers in that country are urged to bring home specimens of the tree from which it is obtained. At the instance of the Government of the Gold Coast, an investigation has been undertaken by Mr. W. H. F. Blandford of the insects destructive to cultivated plants in West Africa. The correspondence is now published which gives the results of this inquiry, and the suggested remedies. An interesting note is reprinted from the *Hawaiian Planter's Monthly*, by Mr. H. M. Whitney, regarding the grafting of the sugar-cane, and the possible production of a graft-hybrid. In the *Diagnoses Africanæ*, No. x., are contained descriptions of some of the novelties included in several important collections recently received at Kew: viz. that of Dr. Forsyth Major from Central Madagascar; that of Mr. G. L. Bates from the Cameroons region; and that of Mr. Alexander Whyte from North Nyasaland, a country which had never previously been explored botanically. Among other subjects referred to in these numbers are the West India sugar-trade, fruit-growing at the Cape, and the use of *Eucalyptus* timber for wood-paving.

THE periodical entitled the *Archives of Skiagraphy* has become the *Archives of the Rœntgen Ray*, edited by Dr. W. S. Hedley and Mr. Sydney Rowland, and published by the Rebman Publishing Company. It is chiefly as a pictorial record of applications of Röntgen photography to surgery that the periodical has found a professional public. This feature will be continued as heretofore, and, in addition, a certain amount of useful letterpress upon methods of work and progress of investigation will be included. The publication will thus not merely deal with the practical usefulness of the new radiation, but also with its scientific bearings. The number before us contains articles upon the nature of the Röntgen Rays, by Prof. S. P. Thompson, F.R.S.; Röntgen Rays, past and present, by Dr. W. S. Hedley; and a number of notes, mostly cuttings from the daily papers. All the subjects of the Röntgen photographs reproduced are of purely medical and surgical interest.

THE fourth edition of "Quantitative Chemical Analysis," by Prof. Frank Clowes and J. Bernard Coleman, has been published by Messrs. J. and A. Churchill. The book has not been modified to any considerable extent, but descriptions of a number of new methods and apparatus have been added.—Mr. Edward Stanford has issued a fourth revised edition of "Epping Forest," by Mr. Edward North Buxton. This excellent little book is not only an interesting guide to all the beauties of Epping Forest, but also a brightly-written handbook of local natural history. Chapters have been added on forest management, the geology of the district, pre-historic man and the ancient fauna, and the entomology, pond-life, and fungi of the forest. There are six large coloured maps, and many illustrations in the text.—A fourth edition of an illustrated handbook of instruction in methods of saving persons from drowning, has been published by the Life Saving Society. The book contains, in addition to a course of instruction in rescue from drowning, descriptions of the methods adopted in resuscitating the apparently drowned, and a short account of the principles underlying them.

THE following are among the papers and other publications which have come under our notice within the past few days:—An eulogy of the late Prof. Alfred M. Mayer, accompanied by a full-page portrait of the lamented investigator, is contributed to *Science* (August 20) by Prof. Le Conte Stevens.—An address on the connection between pharmacy and science, delivered by Prof. E. Shaer at the recent meeting of the German Apotheker-verein, appears in the *Pharmaceutical Journal* (September 18).—A paper containing the results of studies of Mexican and Central American plants, by Dr. J. N. Rose, has been published in the *Contributions* from the U.S. National Herbarium (vol. v. No. 3).—Dr. James Murie writes upon "Our Economic Sea Fishes," in the *Zoologist* (September 15), and describes a few of the results of the study of the life-history of our food-fishes during the past twenty years or so.—The eighth and ninth numbers of Dr. George King's "Materials for a Flora of the Malayan Peninsula," reprinted from the *Journal* of the Asiatic Society of Bengal, have just been distributed. In No. 9 the account of the Calycifloræ is begun. This contribution covers 345 pages, and Dr. King hopes "that one more contribution similar in size to the present one will suffice to complete the account of the Calycifloræ, and so to bring the whole series about half-way towards completion."—Vols. x., xi. and xii. of the *Annalen* of the Imperial University Observatory at Vienna, edited by Prof. Edmund Weiss, have been received. The contents include position observations of planets, comets and nebulæ, made with the various instruments at the Observatory from 1890 to 1893; observations with the meridian circle, zone observations with the 11¾-inch Clark's refractor, and meteorological observations.

THE additions to the Zoological Society's Gardens during the past week include a Chacma Baboon (*Cynocephalus porcarius*, ♂) from South Africa, presented by the Earl of Orkney; a Coypu (*Myopotamus coypus*) from South America, presented by Mr. H. W. Garratt; an Arctic Fox (*Canis lagopus*) from the Arctic Regions, presented by Mr. G. B. Collier; a Grey Ichneumon (*Herpestes griseus*) from India, presented by Mr. Harold Smith; a Water Vole (*Arvicola amphibius*) from Scotland, presented by Master E. Hope Vere; a Levaillant's Amazon (*Chrysotis levaillanti*) from Mexico, presented by Mr. Charles Strong; two Grey-breasted Parrakeets (*Myopsittacus monachus*) from the Argentina, presented by Mr. R. M. Copnall; two Gannets (*Sula bassana*) from Scotland, presented by the Hon. Walter Rothschild; a Marabou Stork (*Leptoptilus crumeniferus*) from

British Central Africa, presented by Captain C. F. Beeching; a Raven (*Corvus corax*) British, presented by the Rev. F. C. A. Barrett; a European Pond Tortoise (*Emys orbicularis*), European, presented by Miss W. Fenwick; a Common Marmoset (*Hapale jacchus*) from South-east Brazil, a Burchell's Zebra (*Equus burchelli*), born in the Menagerie, deposited; two Red Foxes (*Canis fulvus*) from Canada, a Black Woodpecker (*Picus martius*), a Hoopoe (*Upupa epops*), four Little Ringed Plovers (*Ægialitis curonica*), European, purchased.

OUR ASTRONOMICAL COLUMN.

THE CAUSE OF THE PROPER MOTIONS OF STARS.—When the parallax of the star 1830 Groombridge is considered in connection with the large proper motion of seven seconds of arc per annum, the conclusion is arrived at that the star is moving through space with a velocity which probably exceeds two hundred miles per second. In his "Popular Astronomy," Prof. Simon Newcomb briefly discussed the problem of stellar dynamics involved in this enormous velocity. He showed that if the universe be considered of such an extent that light would take 30,000 years to cross it, and if it contained one hundred million stars, having, on the average, a mass five times the mass of the sun, the gravitational attraction of a universe thus constituted would only be sufficient to give a velocity of twenty-five miles per second to a body drawn from infinity to the centre of the system of masses. The calculated limit is thus only about one-eighth the velocity deduced from the observed proper motion and parallax. Prof. Newcomb therefore concluded: "Either the bodies which compose our universe are vastly more massive and numerous than telescopic examination seems to indicate, or 1830 Groombridge is a runaway star, flying on a boundless course through infinite space with such momentum that the attraction of all the bodies of the universe can never stop it."

A new contribution to this inquiry was read recently before the American Philosophical Society by Mr. Luigi d'Auria. The object of the investigation was to determine whether, assuming the interstellar ether to possess the virtue of gravitational attraction, the force exerted by it would be sufficient to account for the proper motions of stars, and especially of the flying star 1830 Groombridge. In this paper it is shown that, "given the ether the density as estimated by Maxwell, and the power of attracting matter by gravity, a body placed within the sphere of ether containing all the stars of the visible universe, and at a distance from the centre of such sphere equal to that passed over by light in 2200 years, would pass this centre with a velocity equal to that of the star 1830 Groombridge, taking into account the attraction of the ether alone; and such body would oscillate about the same centre, rectilinearly, with a period of a little over *seven million* years, which would be also the period of oscillation of every other star." Mr. d'Auria recognises that some other, and unquestionable, cause may eventually prove to be responsible for stellar proper motions, nevertheless he thinks his results are worth putting on record.

NEW DETERMINATION OF THE SOLAR CONSTANT.—A fresh contribution to our knowledge respecting the sun's heat appears in the *Memorie della Società degli Spettroscopisti Italiani*, vol. xxvi., 1897, where Dr. G. B. Rizzo describes a series of observations for determining the solar constant, made at the station "Regina Margherita" on Monte Rosa. The apparatus used was a slight modification of Ångström and Chwolson's; the sun's rays being received on two brass discs attached to thermometers, which were alternately exposed and protected by two aluminium screens so arranged that when one disc was covered the other was exposed. To determine the quantity of solar heat absorbed per unit area per unit time, the formula of Chwolson was employed. Owing to the unsettled weather in September last, when the observations were made, the results were found at times to fluctuate considerably. In determining the solar constant or quantity of heat (measured in calories per minute) incident normally on a square centimetre at the earth's distance from the sun, it is necessary to assume some law for the effect of atmospheric absorption at the place of observation. Dr. Rizzo finds that the formulæ of Forbes and Crova for this purpose, when applied to his present observations, give for the solar constant the respective values 3·133 and 4·934. Both these values are somewhat in excess of the average of previous observations, but the divergence between them renders further investigation desirable.

THE DIAMETERS OF JUPITER AND HIS SATELLITES.—Herr Leo Brenner communicates to the *Astronomische Nachrichten* (No. 3444) the results of recent measures, made by him at the Manora Observatory, of the widths of the various bands and belts on Jupiter, and the angular diameters of the planet and its four large satellites. The following are the results of the measurements of diameters, reduced to mean distance:—

	Equatorial diameter.	Polar diameter.	Oblateness.
	"	"	
Jupiter	38·539	36·134	1 : 16·024
Satellite I.		1·060	
Satellite II. ...	1·063	0·958	1 : 10·123
Satellite III. ...	1·704	1·504	1 : 8·52
Satellite IV. ...	1·550	1·345	1 : 7·568

ACTION OF JUPITER AND SATURN UPON ENCKE'S COMET.—In a memoir which will shortly appear, M. A. Lebeuf gives formulæ for calculating secular inequalities when the mutual inclinations of orbits, and the eccentricity of the orbit of the disturbed body, are known. The formulæ are applied by M. Lebeuf, in the *Bulletin Astronomique*, to determine the secular inequalities of the elements of the orbit of Encke's comet in consequence of the action of Jupiter and Saturn. The values obtained are tabulated below:—

Elements of orbit.	Secular inequality due to Jupiter.	Secular inequality due to Saturn.	Simultaneous action of Jupiter and Saturn.
$\frac{de}{dt}$	+ 1″·38	+ 0″·2	+ 1″·40
$\frac{di}{dt}$	− 25·6	− 0·45	− 26·1
$\frac{d\Omega}{dt}$	− 35·9	− 0·85	− 36·8
$\frac{d\omega}{dt}$	+ 28·3	+ 0·66	+ 29·0
$\frac{d\epsilon}{dt}$	− 133·6	− 3·04	− 136·6

It is pointed out that the large eccentricity of Encke's comet, and the small distance of the comet from Jupiter, makes the use of the formulæ difficult in the case of Jupiter; but the results seem to justify their application to the case of Saturn.

PHASE-CHANGE OF LIGHT ON REFLECTION AT A SILVER SURFACE.

A LIGHT wave, when reflected[1] at the surface of separation of two media, may be altered in amplitude, or wave-length, or phase. Whilst, however, a change of amplitude or wave-length produces an obvious difference between the incident and reflected light, the existence and nature of a change of phase can only in general be inferred from the result of some kind of interference experiment. Thus the fact that a very thin transparent film is black when viewed by reflected light leads to the conclusion that a light wave is altered in phase by half a wave-length on reflection, either at a denser or at a rarer medium. Mechanical analogies suggest that the change probably takes place at the denser medium; and an experiment of Lloyd's, in which coloured fringes with a black centre were obtained by the interference of two beams of light, one directly transmitted, and the other reflected from a glass mirror, led to the same conclusion.

Jamin's experiments on metallic reflection showed that when light is reflected from a silver surface a phase-change is produced, and, moreover, that this change is different according as the light is polarised in, or perpendicular to, the plane of incidence. His experiments led to the determination of the

[1] The term "reflection" is here used in its most general sense, to include such phenomena as phosphorescence, &c.

difference between the phase-changes in these two cases, but gave no direct information as to the absolute magnitude of either.

By depositing a wedge-shaped silver film on the outside of one of the thick glass mirrors of a Jamin refractometer, and observing the interference bands where they crossed from the glass-air to the glass-silver surface, Quincke concluded that the phase-change, when light is reflected in glass from a silver surface, depends on the thickness of the silver, but was unable to decide whether it was a quarter-wave acceleration or three-quarters of a wave retardation for a thick silver film. The reason of his uncertainty will be explained later. Wernicke and Wiener analysed spectroscopically the light reflected from thin transparent plates, the back surfaces of which were partly silvered. The spectra obtained were crossed with black bands, depending in number and breadth on the thickness of the plate; and these bands were displaced where the light was reflected from the silver surface. Wernicke, however, concluded that the phase-change amounted to a quarter-wave acceleration, whilst Wiener concluded that it was of the nature of a retardation of three-quarters of a wave-length. Wernicke has since stated that silver films could be obtained which would produce either of these phase-changes, according to the nature of the film.

A modification of Michelson's refractometer may be advantageously used to study this vexed question. Light from a lamp L, placed at the principal focus of a lens M, falls on the thinly-silvered mirror A, part being reflected along the path

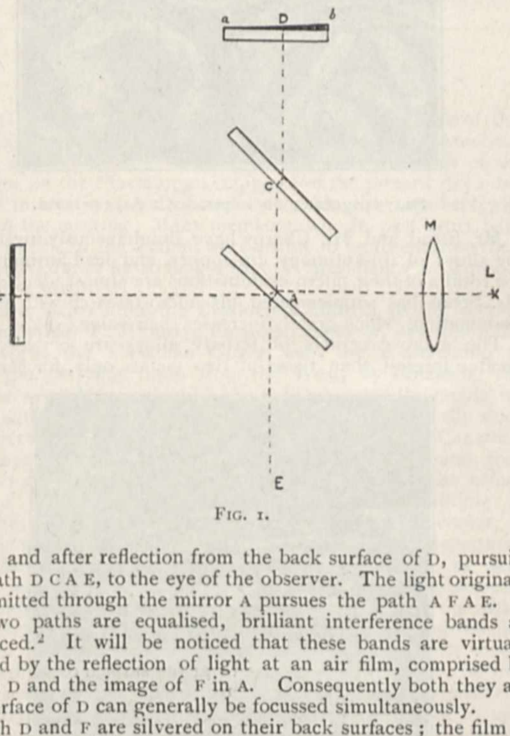

FIG. 1.

A C D, and after reflection from the back surface of D, pursuing the path D C A E, to the eye of the observer. The light originally transmitted through the mirror A pursues the path A F A E. If the two paths are equalised, brilliant interference bands are produced.[2] It will be noticed that these bands are virtually formed by the reflection of light at an air film, comprised between D and the image of F in A. Consequently both they and the surface of D can generally be focussed simultaneously.

Both D and F are silvered on their back surfaces; the film on F is uniform, whilst that on D increases in thickness from one side to the other, as indicated (with exaggeration) by the black line *a b* (Fig. 1). A horizontal strip of glass is also left unsilvered across the middle of D.

The method of obtaining the silver wedge was as follows. The glass was first well cleaned with strong nitric acid, using a small mop made of cotton wool plugged into the end of a glass tube. An ordinary elastic band was then stretched round the plate, and the whole was placed, inclined at an angle of about 30°, in a beaker, and distilled water poured in till it reached the height of the top of the glass plate. A glass syphon tube, reaching to the bottom of the beaker, was introduced, the flow being capable of regulation by a stop-cock on the outer limb. Silvering solution was then quickly poured in through a funnel reaching to the bottom of the beaker. The water was simply displaced upwards, and a few minutes after the silvering solution had reached the level of the top of the plate the stop-cock of the syphon was cautiously opened, so as to slowly withdraw the silvering solution. The flow should at first be moderately quick, but should decrease later. Silver films will be found deposited on both sides of the glass, that on the under side being the better; the film deposited downwards is generally very milky in appearance, and is frequently spotted. If the glass is not washed with nitric acid after the elastic band is placed round it, the silver will be found to gradually shade off towards the clear glass.

The following silvering solution may prove useful to those who wish to make half-silvered mirrors; it was used to form the silver wedges on account of the slowness of its action.

Take silver nitrate 1 gr., dissolved in 20 c.c. of distilled water. Add strong ammonia (·88), drop by drop, till the precipitate formed is just re-dissolved. Add a solution of 1·5 gr. caustic potash (ordinary stick potash works well), dissolved in 40 c.c. of water; then ammonia, drop by drop, till precipitate is just re-dissolved. Add 80 c.c. distilled water, and then a solution of silver nitrate (strength unimportant), till a permanent precipitate is just formed. Make the solution up to 300 c.c. 1·8 grs. milk sugar are dissolved with heating in 20 c.c. distilled water. This solution is added to the above just before silvering is to commence; after a few minutes the whole will commence to blacken. The glass to be silvered may be placed horizontally in an ordinary evaporating basin, and the solution poured in till it reaches the upper surface of the glass. The silver is deposited upwards. For half-silvering about ten minutes is required, when the temperature is about 15° C. For thick silvering the plate should be left at least an hour; we have frequently left it all night with good results. The thick silver film produced may be scrubbed with cotton wool under running water, and finally left for some time in distilled water, when it may be removed and left to dry.

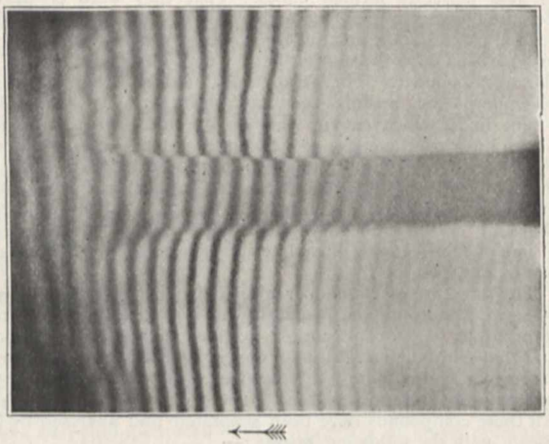

FIG. 2.—The thin edge of the wedge is to the left. A displacement of the bands in the direction of the arrow is produced by lengthening the path A C D (Fig. 1).

The above recipe for silvering was given to us some years ago by Prof. Boys. It was originally due, we believe, to Prof. Liveing.

Fig. 2 is taken from a photograph of the bands produced, using yellow light (the light from an electric arc passed through a cell, made of signal green glass, filled with a saturated solution of bichromate of potash) and a Cadett plate; exposure, one minute.

The dark band across the figure represents the strip of clear glass on which silver was not deposited. The bands, in passing from the glass-air to the glass-silver surface are seen to be displaced towards the thin edge of the wedge-shaped film, and it is at once seen that the displacement depends on the thickness of the film. In order to produce a displacement of the bands in the same direction, the length of the path A D must be increased. This, according to Wiener, would indicate that the light was retarded on reflection from thick silver by three-quarters of a wave-length. It will be noticed that the bands are continuous, passing from the glass-air to the glass-silver surface. This is

[2] For a simple method of constructing this apparatus, see NATURE, August 17, 1893, "Apparatus illustrating Michelson's method of obtaining interference bands." Following Michelson, it was there stated that the central band is always black. We have since determined that the colour of the central band will vary according to the phase-changes produced at the various silver surfaces. We have been able to obtain a white central band.

due to the fact that the silver gradually shades off towards the clear glass. Occasionally, however, each band, in passing from the glass-air to the glass-silver surface, is joined to *both* the nearest bands on the silver. It was due to this cause that Quincke was unable to say whether an acceleration or retardation was produced.

Wernicke states that a retardation is only produced when the silver is of a friable nature, and could be readily rubbed off the glass. The accompanying photograph was obtained with a silver film that easily bore polishing, and showed no want of adherence to the glass.

E. EDSER.
H. STANSFIELD.

MICRO-STRUCTURE OF ALLOYS.

AT the Royal Society's conversazione this year, Mr. J. E. Stead exhibited a series of photographs illustrating the micro-structure of various alloys. In many cases the structure portrayed was very complex and interesting, and in some cases beautiful.

Many series were illustrated by Mr. Stead, but it would take much more space than is available in a short notice to more than point out briefly the main features of a few.

The photographs showed that when the antimony exceeded 7·5 per cent. in antimony-tin alloys, the excess over that amount separated out with an equal atomic proportion of tin as more or less perfectly formed cubes. That they were crystals of definite chemical atomic composition Mr. Stead had verified by several careful analyses after having dissolved away the eutectic, or what was once the mother liquor, with nitric acid, which left the crystals intact. The photographs of alloys of tin containing phosphorus and arsenic had the appearance of very straight bright lines, which cut up the surface into irregular figures. These lines are the edges of flat plates, which, when separated by dissolving away the tin, have been proved by analysis to have the composition of Sn_3P_2 and Sn_3As_2, respectively. The photographs of the separated compounds indicate that they had both the same crystalline form of hexagonal plates. A photograph of one of the free ends of a plate showed several pointed crystals having angles of 60°.

The structure of tin-copper alloys rich in tin was illustrated by several photographs, which showed that in alloys containing from 2 to 0·10 per cent. copper acicular crystals were present, and that with each addition of copper the separated compound assumed a more plate-like structure, until when 35 per cent. copper was present, apparently it was all in the form of plates. All these compounds have been separated and analysed by Mr. Stead, with the following results :—

Alloy.		Crystals separated. Copper.	Tin.	
98·0 °/₀ tin, 2·0 °/₀ copper	...	34·58 °/₀	65·42 °/₀	SnCu (approximate.)
97·0 ,, 3·0 ,,	...	36·50 ,,	63·50 ,,	
95·0 ,, 5·0 ,,	...	39·80 ,,	60·20 ,,	
90·0 ,, 10·0 ,,	...	44·60 ,,	55·40 ,,	Sn_2Cu_3 ,,
85·0 ,, 15 0 ,,	...	47·20 ,,	52·80 ,,	
80·0 ,, 20·0 ,,	...	53·00 ,,	47·00 ,,	
65·3 ,, 34·7 ,,	...	56·12 ,,	43·88 ,,	$SnCu_2$,,

It will be seen that although the compound separated from the 2 per cent. alloys approximates to the composition of SnCu, each addition of copper to the alloy results in the formation of a compound which after separation proves to contain a greater proportion of copper than that from the alloy containing less copper.

It has not yet been proved whether these compounds are amorphous mixtures or combinations of one or more atomic chemical constituents.

It appears that in all the solid alloys of lead and antimony the elements are in a free state. There is a eutectic which contains 12·7 per cent. antimony. Those having more than that quantity of antimony contain large crystals of free antimony, which until 50 per cent. is present are found at the upper part of the alloy if the cooling of the liquid alloy has been sufficiently slow, but between these crystals the eutectic is clearly visible. When the antimony is increased to 50 per cent. the white crystals and dark eutectic occupy nearly equal areas, and with each addition of antimony the dark areas diminish until when 100 per cent. is present the surface presents a homogeneous white appearance free from the dark eutectic.

With alloys containing less than 12·7 per cent. antimony the polished and etched surfaces clearly show the presence of dendritic crystals of lead.

The eutectic has the very peculiar structure similar to that of nodular radiated pyrites. On treating this compound with dilute nitric acid for a long period, a coherent dark-coloured mass is left free from lead, and which appears to consist when broken up as very fine bright plates, exceedingly thin and easily broken up, with the slightest pressure, into what appears to be an amorphous powder.

FIG. 1.—× 30.
Sn, 75 per cent. ; Sb, 20 per cent. ; As, 5 per cent.

Mr. Stead and Mr. Charpy have simultaneously investigated the alloys of tin-antimony, tin-copper, and lead-antimony, and the results of their micro-examinations are almost identical; but Mr. Stead has supplemented his micro-research with chemical examination, which greatly increases their value.

The micro-structures of ternary alloys are of very much greater interest than those of two metals only, for Mr. Stead

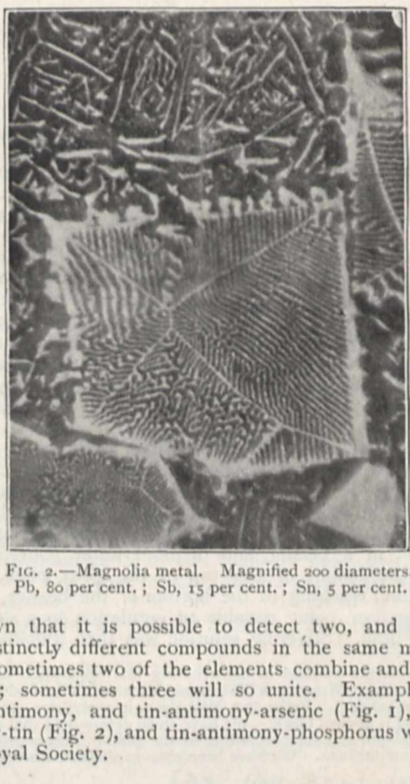

FIG. 2.—Magnolia metal. Magnified 200 diameters.
Pb, 80 per cent. ; Sb, 15 per cent. ; Sn, 5 per cent.

has shown that it is possible to detect two, and sometime three, distinctly different compounds in the same microscopic field. Sometimes two of the elements combine and crystallise together ; sometimes three will so unite. Examples of tin-copper-antimony, and tin-antimony-arsenic (Fig. 1), and lead-antimony-tin (Fig. 2), and tin-antimony-phosphorus were shown at the Royal Society.

The photographs show that in the tin-antimony-copper (tin being in large excess) the copper-tin in the form of needles or plates crystallises out quite separately and independently of the antimony-tin compound which exist as cubes, and both occur side by side in the same alloy. A similar thing occurs with the tin-antimony-phosphorus alloys, the plates of phosphide of tin, and the cubes of antimonide of tin being clearly separate. The eutectic of magnolia metal (lead 80 per cent., antimony 15 per cent., and tin 5 per cent.), under high magnification presents a very beautiful structure, quite different from that of lead and antimony alone, and the fine delicate structure (Fig. 2) apparently consists of crystallites of the cubic system, and these possibly are a combination of the three metals present.

The structures of the tin-antimony-arsenic alloys are very remarkable, and evidently the crystals formed consist of what might be called tin-antimony-arsenides, for they all crystallise together in a fusible eutectic. The alloy, containing tin 75 per cent., antimony 20 per cent., arsenic 5 per cent., presents a most interesting appearance (Fig. 1); the sections of the white crystals are of more or less perfect circular form, and in the solid alloy they exist as spheres, the fractured surfaces proving this to be the case.

Micro-metallography is a comparatively new science, the borders only of which have been but slightly studied, but it promises to give results of the highest scientific interest.

MECHANICS AT THE BRITISH ASSOCIATION.

PERHAPS the most noteworthy feature in the work of this section (G) was the prominence of the Canadian and American papers, apart from the interesting and suggestive address of the President on the education of engineers of the present day; but little of interest was contributed by the English members who attended the meeting. Many members, who in past years have done so much for the section, were unable to be absent from their professional duties for so long a time as attendance at Toronto necessarily involved.

The first paper after the President's address to the section was one by Mr. T. Munro, a Canadian engineer, describing the great works the Canadian Government are constructing to secure the carrying trade from the West, by canalising the rivers between Montreal and Lake Erie wherever the rapids interfere with traffic. The traffic has grown so enormously since the construction of the trans-continental line of the Canadian Pacific opened up the great western plateaus for settlement, that the older systems of canals are practically useless. The actual piece of work described in the paper was the building of Soulanges Canal, on the northern bank of the St. Lawrence, a short distance above Montreal. Two very important departures from ordinary practice were adopted on the advice of Mr. Munro, who was sent on a tour through Europe by the Government before the work was planned: in the first place, the locks are practically all at the Montreal end of the canal, and the lift in each lock was much greater than had previously been attempted in Canada, the locks being also of great size; in the second place, Portland cement concrete has been extensively used. Hitherto Canadian engineers have been afraid to use this valuable material in their canal and harbour work, mainly on account of the fear that the severe Canadian winters would break up such material; partly also, at any rate, until a few years ago, from the difficulty of obtaining trustworthy cement. Recent advances in the manufacture, both in England and the Continent, stimulated mainly by the exhaustive series of tests carried out on Portland cement by Bauschinger and others, have resulted in putting at the disposal of Canadian engineers a material thoroughly trustworthy and uniform in quality; and Mr. Munro's experience has proved decisively that with adequate care in the preparation and use of the concrete it is perfectly safe in the most rigorous Canadian winter.

At Montreal the members of the section had the opportunity of thoroughly inspecting the magnificent engineering laboratories of the McGill University, built and equipped by Mr. McDonald, one of the most generous in his gifts of the many public-spirited citizens of that flourishing city. These laboratories are in many respects the most perfectly equipped in existence, especially the hydraulic room designed by Prof. Bovey, where the visitors were shown most ingenious appliances for studying some of the more difficult problems in hydraulics, some of the appliances as, for example, the experimental steam pump, which has just been installed, being on an extensive scale, and fitted for all the requirements of complete research work. Prof. Bovey supplemented this visit by a paper read before the section describing in detail the various appliances in this hydraulic laboratory.

One of the most interesting discussions in the meeting of the section was started by another paper of Prof. Bovey, describing the method of testing Canadian timbers at the McGill laboratories, and the results he had obtained as to the influence of moisture on the strength and elasticity of the various woods experimented on. The timber industry is such a valuable one, both to Canada and the States, that special attention has been devoted to the thorough testing of the economic values of the different forest trees. It should be remembered, however, that Bauschinger indicated the true method of making such tests in his memoirs on testing of timber specimens: all the later experimenters have simply followed in his footsteps The results of the exhaustive tests carried out in the States by Prof. Johnson have been published in a series of Bulletins by the Forestry Branch of the Department of Agriculture at Washington; these form a valuable series for reference.

Prof. Callendar described in a brief, but most valuable paper, which will be published *in extenso* in the transactions of the British Association, the apparatus devised by himself and Prof. Nicolson for studying the rate of condensation of steam when in contact with metal surfaces at various temperatures and pressures. The research is still incomplete, so that it is impossible to deduce any very certain generalisation from the results so far obtained with the apparatus; but one thing has been clearly brought out, namely, that the rate of condensation is not as great as has hitherto been assumed in theoretical investigations into this all-important question in the true theory of steam engine efficiency.

On the Saturday the members of the section had the opportunity of joining an excursion to Niagara, and of seeing while there the various power-houses, and some of the industries which make use of and depend for their existence on this cheap and abundant power. Nothing has been more instructive to English visitors than the constant utilisation of the energy of the falls and rapids, so abundantly distributed all over Canada, and nothing perhaps more striking than the fact that some of these power companies find it difficult to dispose of the power they are ready to supply, a testimony to the truth of the statement that after all in many very important industries the cost of power is not a very serious factor in the cost of production.

As every city of any size, both in Canada and the States, is always well equipped with electric tramcars or street railroads, usually running many miles out into the country around, it was only fitting that the section should devote a good deal of its electrical day to papers on this question, so rapidly becoming one of the leading problems of municipal engineering work in Great Britain.

Mr. Cunningham, the engineer responsible for the construction and working of the very complete system in use in Montreal, read a paper descriptive of that work, but in doing so he dealt fully with the whole question of electric as opposed to other systems of traction. Here, again, many members had had an opportunity of inspecting the power-house of the company at Montreal, and were able, therefore, to follow more readily the author's description of the plant in use.

Mr. Cunningham, no doubt, somewhat overstated his case when contrasting the cost per car mile of the horse system of Liverpool with the electric system of Montreal; it is certainly not a fair comparison to take the mere cost of power as delivered from the power-house, neglecting all the expense of maintaining the generating plant in prime cost condition, repairs to car motors, lines, &c., and then to contrast this with the published cost of haulage per car mile of some horse system, where not only has the cost of fodder and wages of stablemen been included, but also the heavy outlay of up-keep of the horse stock. There can be no doubt that such comparisons have often led municipal and other authorities in Great Britain to look with great suspicion on estimates of electric street railway systems, and have at times hindered their adoption. The distinct economy of electric haulage, when every item of cost has been fairly brought into the bill of charges, is so clear that it needs no such unfair method of comparison to bring it home to those interested in tramway work.

There was a long discussion on this paper, and on a second paper, by Mr. Aldridge, descriptive of a very ingenious but somewhat complicated electric system designed to get rid of the overhead wire, the car itself carrying a length of wire overhead sufficiently long to make connection between a series of poles and studs in the paving. The general opinion of all the electrical engineers who took part in it, both British and American, seemed to be that for smaller towns with comparatively uncrowded streets, and for the outlying roads of great cities, especially those extending into residential suburbs (most of the existing tram-lines in London run mainly on such roads), the overhead trolly wire system was at present, at any rate, the only possible system; its great cheapness and simplicity, as compared with all conduit systems, practically gave it a monopoly. For the main business streets of great cities, however, if street tramways are to be allowed at all, a somewhat doubtful point, then some system which abolishes both the overhead wire and the open conduit seems the ideal one. At present no satisfactory one has yet been brought into use. One thing is certain: every British visitor to Toronto, after experiencing the comfort and value of the quick, well-lit, and frequent car service of that city, will return to the Old Country an ardent advocate of the adoption of electric traction on our street-cars. The contrast between this splendid system of street-cars and our slow, wretchedly-lit system is so great, that one can only wonder that we have put up with the latter so long. The abolition from our streets of the thousands of horses required by tramcars and busses, is of itself a great argument in favour of electric traction; the filth of the streets would at once be sensibly reduced, and we should be spared the pain of seeing the sight—now only too common in our streets—of overworked horses struggling painfully to start overloaded cars and busses.

The bugbear of the hideousness of the overhead wire is, let us hope, at last being seen in its true light; in any street of Toronto, where the overhead wires of the car-system were the only ones, they were inconspicuous and almost unnoticeable; the people responsible for the frightful mass of wires and poles which disfigure the leading streets of American cities, are not the tramway companies, but the telegraph, telephone, and electric light companies. The overhead wire tramway poles would be practically unnoticeable in any street of an English city; and most certainly there are very few, if any, streets where they would be obtrusive, or do anything to increase the already, alas, existing prevalent ugliness.

The conditions of modern city life, the absolute necessity of the worker living—if he is to secure a healthy cheap dwelling—miles from his place of work, render imperative some system of cheap and efficient transport through the streets. Though our underground electric railways may do something towards solving this problem in London, still, in the other cities, and in London itself, the street-car must be the chief method adopted; and it is monstrous that we should still be compelled to put up with our antiquated and inefficient system of horse traction, while every little town of mushroom growth in America has already solved the problem, and given its inhabitants the most perfect systems of street traction. Liverpool is to show the way; let us hope, that in a year or two the electric street railways of great Britain will increase so rapidly that we shall be able to compare them, as regards mileage, with the thousands of miles already in use across the Atlantic. If the meeting of the Association in Toronto should hasten on this desirable social improvement, it will not have been in vain, and will be looked back to with pleasure by all those anxious to make life in our great cities more healthful and more perfect.

THE WORK OF PASTEUR AND THE MODERN CONCEPTION OF MEDICINE.

MR. PRESIDENT, LADIES, AND GENTLEMEN,—It is not without emotion that I rise to address this learned assembly. I know, indeed, that I am addressing men who are not my fellow citizens, but among them are some, *enfants de notre vieille nation Gauloise*, who have the same mother tongue as we; they speak from childhood our beloved French language, they are thus a little more than my fellow citizens, for they are my compatriots, and I feel myself animated by a truly fraternal affection for them; and as to my English colleagues, they have given evidence of so much good will and of a courtesy so delicate, that I need make no great effort to assure them of my gratitude. In one word, although a stranger I seem to be among friends.

I am somewhat troubled, also, because I am addressing medical men and am speaking before a medical congress. Now, although I belong in some small degree to the great medical family, since my father has conferred honour upon the profession of medicine by his labours and by his works; and although I have the great honour to be the delegate of the Faculty of Medicine of Paris, yet I am not a medical man, and a physiologist displays some temerity in venturing to speak before you on medical matters.

THE RECONCILIATION OF MEDICINE AND SCIENCE.

Still I have an excuse. It is this, that I desire to attempt to bring about a complete reconciliation between medicine and science. It may seem that this is a commonplace, and that any such attempt would be unnecessary. But it is not so, gentlemen. We might find, perhaps, somewhere—not, I am sure, in this assembly—medical men ready, unhesitatingly, to assert that there is discord between medicine and science, and that all those sciences which are called auxiliary—physics, chemistry, physiology—are *impedimenta* with which the clinician has nothing to do. Yes, there are to be found in the world medical men, among them even men of high attainments, who are ready still to say: "What have I got to do with your experimental science? Observation of the sick and clinical study are worth more than all your clever experiments, and it is not from laboratories that the means of curing disease can come." Such an opinion appears to me to be erroneous, and I would with all the energy which I possess help to upset it. I hold that it is by experimental science alone that medicine has made and can make progress. It will suffice to describe the work of Pasteur, my illustrious master, in order to give you a convincing demonstration of this.

I shall not be contradicted when I say that the value of this work is greater than all that the history of medicine has given us since the commencement of our era. Through his labours everything has been renewed, regenerated, and, thanks to him, medicine has made more progress in twenty years than had been made previously in twenty centuries.

THE LIFE-WORK OF PASTEUR.

Louis Pasteur was born at Dôle in the Jura in 1821, and at the beginning of his career gave himself up to the study of chemistry. He became deeply interested in a difficult and important problem—molecular dissymmetry. Here was a question in pure chemistry which would seem to take us very far from medical questions, but it was to lead Pasteur directly to the study of fermentations. If a solution of tartaric acid (in the form of tartrate) be left untouched, a change occurs after some time in the chemical constitution of the liquid, which before Pasteur's time had been overlooked. The original solution had no action on polarised light, but after fermentation this same solution has become capable of deflecting polarised light. Pasteur explained this phenomenon by showing that the original tartaric acid is a mixture of an acid deviating light to the right with an acid deviating it to the left, and that a process of partial decomposition takes place; one of the acids is destroyed and the other is not altered, so that the action upon polarised light, previously masked by the mixture of the two acids, becomes evident. Here we have a fundamental experiment. It is told how when the young Pasteur desired to show it to Biot, that great physicist, who had discovered the phenomena of polarisation, the old *savant* grasped the trembling hand of the young man, and, before beginning the optical examination of the crystals submitted to him by Pasteur, said to him with tears in his eyes, "*Mon cher enfant*, I have loved science so much, that in face of the beautiful experiment which you relate to me I cannot prevent myself from being deeply moved."

The explanation given of this phenomenon at that time was that the tartaric acid was decomposed by fermentation. Men were then content to use this magic word, which appeared to explain everything, but which in reality told nothing at all. Neither Lavoisier, nor Liebig, nor Frémy had been able to discover its meaning, and were reduced to the theory of half-organised matter—a childish conception worthy of Paracelsus.

One of Pasteur's experiments, perhaps the most beautiful which he ever made, demonstrated the nature of this mysterious phenomenon. If a sugary solution of carbonate of lime

[1] An address delivered before the British Medical Association, at Montreal, by Prof. Charles Richet. (Reprinted from the *British Medical Journal.*)

is left to itself, after a certain time it begins to effervesce, carbonic acid is evolved, and lactic acid is formed, which decomposes the carbonate of lime to form lactate of lime. This lactic acid is formed at the expense of the sugar, which disappears little by little. But what is the cause of this transformation of sugar into lactic acid? Well, Pasteur showed that the efficient cause of this chemical action was a thin layer of organic matter; that this layer of organic matter consisted of extremely small moving organisms, which increased in number as the fermentation went on. Their growth it is, then, which produces the phenomenon of the transformation of sugar of milk into lactic acid. If, for example, we take a sugary solution in which all pre-existing germs have been destroyed by heat, no lactic fermentation will take place. But if we introduce into this sterile liquid a small quantity of this layer of organic matter, such as can be obtained from any liquid in which normal lactic fermentation is taking place, we shall see the lactic acid again form rapidly in the new solution.

Let us dwell a little on this admirable experiment. Nowadays it seems to us so extremely simple that we can scarcely perceive its importance. It seems to us now, in 1897, that from all time we must have known that an organic solution when heated was sterile, and that a germ would suffice to render it capable of fermentation. But this is a mere delusion. No, a thousand times no! This great fact of the generation of germs was absolutely unknown before Pasteur, and the method of sterilising liquids, and of their inoculation with spores, was revealed to us by Pasteur. It is the nature of great discoveries that they become popularised in a short time, and thus very quickly become elementary. A first year's medical student knows perfectly that which neither Lavoisier, nor Liebig, nor Frémy, nor any one before Pasteur had been able to perceive. We are always tempted to be ungrateful to great creators, for their creations pass rapidly into the domain of common knowledge. They become so simple that they cease to surprise us. We do not think of being grateful, and we forget the efforts which genius has had to make to wrest the truth from jealous nature. Gentlemen, let us not be ungrateful, let us remember that the recognition of the real cause of all fermentation (the development and germination of organised elements) dates from 1857, and from the celebrated memoir of Pasteur upon lactic fermentation. A new world was then opened to science.

Nevertheless, this memoir of Pasteur's, containing one of the fundamental discoveries of the century, was not welcomed as it ought to have been. At first its importance was not understood, and afterwards absurd contradictions were opposed to it. A whole series of beautiful and decisive experiments was necessary to prove that there was no such thing as spontaneous generation, and that sterile liquids remained sterile indefinitely so long as no germs were introduced into them. Pasteur devoted six years (1857-1863) to the proof of the fundamental fact that "organic liquids do not alter until a living germ is introduced into them, and living germs exist everywhere."

THE MICROBIC THEORY OF DISEASE.

A great step yet remained to be taken. This was to determine the evolution of these germs, not merely *in vitro*, but in the living organism. We to whom the idea of parasitism and microbic infection is now so familiar can scarcely conceive that it has not always been thus.

The microbic theory has become so ordinary, so popular, that we are tempted to believe that the part played by microbes was understood even in the times of Hippocrates; but I assure you that in truth this was not the case, and for long enough after Hippocrates the power of microbes was not known.

Pasteur, to whom, and to Sédillot and Littré, we owe the word "microbe," was the first also to explain to us in his essay on the silkworm disease, published in 1867, the part they played in the production of disease. He proved that the bright corpuscles found in the bodies of diseased silkworms are living germs—a distinct living species, a parasite which can multiply and reproduce itself and disseminate the contagion.

It was therefore with painful astonishment that I heard Prof. Marshall Ward recently say that the discovery of the part played by micro-organisms in disease was due to Koch, and dated from 1876. Now, ten years before this, Pasteur had published his experiments on *pébrine* and *flacherie*. Davaine had shown the part played by bacteria in anthrax infection, and the idea of infection and of contagion by microbes in the higher animals as well as in the lower had become a commonplace, not indeed in the medical world, but in all laboratories.

Thus, by successive steps, did the work of Pasteur develop in all its greatness and logic. In the first place, in order to elucidate a chemical problem, he studied tartaric fermentation; then he was led to study lactic fermentation, and he showed that they were biological phenomena. He then pursued the analysis of this phenomena with all its consequences, and was led to the conception that disease was due to the development of a parasite.

The normal living being follows out its course of growth without the development of any organic parasite in its tissues or in its humours. But if these humours or tissues happen to be inoculated with any organism capable of developing, then this small living thing multiplies, the higher organism is infected, and the whole body becomes, as it were, a culture fluid, in which the pathogenic microbe propagates itself, a centre of infection which scatters the disease by sowing the noxious germs wherever it goes. Thus arose the new conception, profoundly new not only for medicine but for hygiene—Disease is Parasitism. Thenceforth we understood the meaning of the words "infection" and "contagion," previously mysterious.

It is true that Pasteur did not discover all the microbes of all contagious diseases; but this is of small moment, since he was the first to discover that infection was a phenomenon of microbial parisitism. All those who after him have proved points of detail, however important or fundamental they may be, have but followed the path traced by the master. Whether they will or not, they are all the pupils of Pasteur, as those who follow the study of chemistry are pupils of Lavoisier.

The greatest of Pasteur's disciples, Robert Koch, although with some ingratitude he refuses to recognise his master, has only perfected certain points in technique and applied his ingenuity and his perspicacity to the solution of questions which, in spite of their practical importance, are still secondary. He has not, in fact, been able to do anything new except upon points of detail; all that is essential comes from Pasteur himself.

Need I say that this idea of the microbe, of the parasite, has become the basis of medicine. If we take up treatises on pathology written before this prodigious revolution, we shall be astonished by the insignificance and the nothingness of these very ancient books. Yet they are not really very old; they are dated 1875 or 1880; but as one reads them it seems as though several centuries must have intervened between these venerable writings and modern books. I know an excellent article on tuberculosis written in 1878, before the microbe of tuberculosis had been discovered. Well, this article belongs to another age; it belongs no longer to medicine, but to the history of medicine, for it swarms with mistakes and incredible errors with regard to pathological anatomy, etiology, prophylaxis, treatment—in fact, from every point of view.

In ten years medicine has been entirely overturned and remade. It is being re-made every day. Every day brings some new discovery in matters of detail; but the great principle is always there, and it must always be attributed to the one initiator.

This is not all. Another new and great discovery was to be made by Pasteur himself, and to constitute the supreme development, the culminating point, as it were, of his life's work. This is the principle of vaccination. By a series of researches, admirable for their precision, Pasteur proved that the pathogenic microbe could be attenuated—that is to say, rendered incapable of causing death. But, though this microbe does not cause death, yet it can produce the disease, a disease sometimes so attenuated as to be almost imperceptible. Now the living being which has suffered from this attenuated disease is protected against its more serious forms, and, borrowing the word consecrated by the immortal discovery of Jenner, Pasteur said that we have here "vaccination."

Fermentation, infection, contagion, vaccination; here in four words we have the work of Pasteur. What more need I say? Do not these four words possess, in their simplicity, unequalled eloquence.

Can any one longer maintain that the progress of medicine is not due to experimental science? Does not all this knowledge of microbes and of the part which they play in disease imply, immediately and necessarily, immense progress in therapeutics?

ANTISEPTIC SURGERY.

To take but one example, I will cite the application of microbial theories to surgery.

There was a time when erysipelas, purulent infection, and hospital gangrene decimated those upon whom operations had been performed, when puerperal infection claimed a terrible number of victims. It seems to us nowadays that the medical profession before 1868 were blindfolded, and that their blindness was almost criminal. These are now no more than historic memories. A sad history, doubtless, but one which we must look at coolly in order to understand what science can do for medicine. Left to their own resources, practitioners of medicine during long centuries could do nothing against erysipelas, against purulent infection, against puerperal infection; but, basing itself upon science, surgery has been able to triumph over these odious diseases, and to relegate them to the past.

Let me here introduce a reminiscence. When on the occasion of his jubilee, a great celebration was prepared for Pasteur in the Sorbonne, in the presence of the leading men of science of the world, there was a moment when all hearts were softened—the moment when the great surgeon who was first to perceive how to apply to the practice of his heart the theory of pathogenic parasites, when Lord Lister drew near to Pasteur and gave him a fraternal embrace. These two great benefactors of humanity, united in their common work, afforded a spectacle never to be forgotten, a striking reconciliation of medicine with science.

But the apogee of the glory of Pasteur was the discovery of the new treatment of hydrophobia. No one of his scientific conquests was more popular, and from France and from the whole world there arose a long cry of admiration. Perhaps in the eyes of biologists this discovery possesses less importance than his labours with reference to the fermentations and to vaccination, but for the public this was the chief part of Pasteur's work. And men of science also were forced to admire the scientific courage of Pasteur, who, putting aside the precise methods which he had taught and discovered, knew how to devise new methods to meet the exigencies of the circumstances, and how to put them victoriously into practice.

Thus was finished the work of Pasteur. He was spared to take part in the triumph of his ideas, and to be a witness of his own glory. If, like so many creators, he had sometimes in his earlier days known conflicts and hatreds and petty quarrels and foolish objections, nevertheless he had not to deplore the ingratitude of mankind. He died full of honours, surrounded by admiration, respect, and love. For him posterity had already commenced when he died.

THE UNION OF MEDICINE AND SCIENCE.

And now let us turn back to consider the indisputable union of medicine and of science. This, in fact, is what ought to strike us in the work of Pasteur. It is not only in general biology and in the progress of our knowledge that his work is great; it is still more in its immediate practical applications. The great biologists of our century, Lavoisier, Claude Bernard, Darwin, have, without doubt, left behind them work which by reason of its conquest of new truths is not inferior to the work of Pasteur, but these new truths do not lead to any such immediate application as antisepsis, the treatment of hydrophobia, anthrax-vaccination, or the prophylaxis of infectious diseases. Pasteur was not only a man of science, he was also a philanthropist, and there is scarcely one who can be compared with him as a benefactor of suffering humanity except Jenner, who found out how to preserve thousands and thousands of human beings from the most hideous of all diseases.

Further, Pasteur brought back medicine into the true way of science. Even after Magendie, Müller, Schwann, and Claude Bernard, it might still have been asked whether all these experiments establishing so many important truths had really been of any advantage for the relief of the sick. To discover, as did Schwann, that living beings are an aggregate of cells; to prove, as did Claude Bernard, that the liver forms sugar; to establish, as did Darwin, that living species can be transformed by the influence of long-accumulated variations in the environments—these are admirable pieces of work, but work in pure science which had not any immediate therapeutic results. Strictly speaking, then, it was possible to maintain that clinical medicine did not derive any benefit from such investigations. I do not for a moment believe that this opinion had a shadow of a foundation, but before the time of Pasteur it was not so absurd as it has become since Pasteur. Since Pasteur no man can, without incurring the charge of monstrous ineptitude, refuse the rights of citizenship in medicine to experiment and to biology.

And to speak the truth, men of science and biologists, as though their ardour had been redoubled by the renovation of medical ideas, have during these last ten years made discoveries which have introduced into medical science new elements which clinical observation alone had been absolutely incapable of discovering. I will cite a few examples—the action of the thyroid gland, the Röntgen rays, pancreatic diabetes, and serum therapeutics.

THYROID IN THERAPEUTICS.

Physiologists had shown long ago that the ablation of the thyroid gland led to serious results. Schiff had proved this as long ago as 1857, but the explanation of the phenomenon did not become clear until Claude Bernard, but especially Brown-Séquard, had demonstrated the existence of internal secretions of glands pouring into the blood their products which probably neutralise certain toxic substances. This very naturally led Vassale and Gley to inject into animals from whom the thyroid gland had been removed the juice of the thyroid, and thus prolong their lives. The therapeutic conclusion to be drawn was obvious, namely, to treat the unfortunate subjects of cretinism or of diseases of the thyroid gland by injection of extracts of the thyroid body. You know that the result has been most happy.

This new treatment was a true experiment, and as is the case with so many experiments, the actual result has been a little different from that which was expected. The ingestion of thyroidin is not only a means of curing goître and cretinism, but is only a treatment, sometimes remarkably efficacious, for obesity.

THE RÖNTGEN RAYS.

The discovery of the Röntgen rays excited general enthusiasm, and as a matter of fact it is one of the greatest conquests of contemporary physics. Most assuredly medicine had nothing to do with it. The research was made and the success was obtained in a physical laboratory. Now you are not unaware that these Röntgen rays have been called to play a part, if not in the treatment at least in the diagnosis of diseases—a part the importance of which goes on increasing from day to day. Physicists have discovered the principle, it is for medical men to follow up its application.

PANCREATIC DIABETES.

The existence of pancreatic diabetes was suspected vaguely by a clinical physician, Lancereaux; but the means which clinical medicine and pathological anatomy placed at his disposal did not give him the power to solve the problem. In spite of his perspicacity, he could do no more than note a certain correspondence between diabetes and lesions of the pancreas. How could more have been learnt if we had not the resource of experiment? Two physiologists, Mering and Minkowski, have had the good fortune to show that ablation of the pancreas determines glycosuria, to show that there is a pancreatic diabetes, and they have studied its various conditions with great ability.

SERUM THERAPEUTICS.

I come now to serum therapeutics, a direct consequence of the labours of Pasteur. This is a mode of treatment born of the experimental method alone. Here, again, science has done for the art of medicine that which clinical observation, left to its own resources, could never have accomplished.

Permit me now to show how serum therapeutics is derived directly from physiology and experiment, and pardon me if I am forced to speak of my own work; I shall do so I hope without any vanity. I know very well that we always owe to our predecessors and to our rivals much more than our pride admits, and that the experiments and the ideas which succeed are not always those which have been conceived most methodically.

About 1887 M. Chauveau had shown that French sheep could contract anthrax, and that they are very easily infected by the bacillus anthracis, the microbe of anthrax, if small quantities of the bacillus be injected under the skin. But Algerian sheep seem to be safe from the disease. In vain is the bacillus anthracis injected into them; they do not contract anthrax. They are refractory to this disease and possess a remarkable immunity to it. Having reflected on this strange fact I framed the hypothesis that the cause of the immunity of the Algerian sheep, which are absolutely similar from the anatomical and zoological point of view to French sheep, depended upon chemical substances contained in the blood, and that in consequence we might hope to confer immunity on French sheep by transfusing into them the blood of the Algerian sheep. It is, however, difficult to make experiments on sheep. Therefore, with my friend Héricourt, who has been throughout these researches my tireless fellow worker, I took animals of two different species, the common victims of physiologists—rabbits and dogs.

Just at that time we had been studying a microbe nearly related to the staphylococcus albus, the staphylococcus pyosepticus, which in rabbits produces enormous subcutaneous swellings when injected under the skin and causes death in twenty-four to thirty-six hours. The dog, on the other hand, seems to be almost refractory to inoculation with this microbe. We therefore attempted to transfuse the blood of the normal dog into rabbits by intravenous injection, but this operation did not succeed, for the transfusion of dog's blood into the veins of the rabbit even in a dose of only 10 gm. rapidly causes death.

In then occurred to us to resort to peritoneal transfusion in place of intravenous transfusion. In this way we were able to introduce into the organism of the rabbit 50 or 60 gm. of dog's blood, and had the good fortune to see the experiment succeed completely. Rabbits transfused with the blood of the normal dog survived the inoculation of the microbe for four or five days, and rabbits transfused with the blood of a dog vaccinated against the microbe did not die, and were in fact hardly ill at all.

This experiment, which was made on November 5, 1888, is, as it seems to me, the very basis of serum therapeutics; it in fact proves that the blood of animals refractory to a disease contains chemical bodies which counteract the effects of the specific pathogenic microbe of the disease. We understood its importance from the first, and having established the general pathological principle, we resolved to apply it to a disease of man.

For several days, then, Héricourt and I debated the question whether we should experiment with one or other of the three diseases—anthrax, diphtheria, or tuberculosis. Unfortunately we decided for tuberculosis. Its microbe is easily cultivated, and, as you know, it produces greater ravages among men and animals than any other disease. We set to work at once, but, as you will understand, time was required before we could obtain definite results. Still, in a year's time we were able to show that the injection of dog's blood into rabbits retarded enormously the development of tuberculosis. It was, nevertheless, necessary to pass from experimental physiology to human therapeutics. Taking advantage of an observation of Bouchard's to the effect that the serum of refractory animals is as active as the whole blood, we were able to inject the serum in tuberculous diseases. The first sero-therapeutic injection was made by us on December 6, 1889.

At first we had for a space great hope. Yes, in truth, for several weeks we believed that we had discovered the heroic treatment of tuberculosis. For several weeks the various patients that we had under treatment found that their strength was renewed, that their appetite returned, that their weight increased, and that cough and expectoration disappeared almost completely. But, alas, it was no more than a transient improvement. A month or a month and a half later the pitiless disease resumed its course, and the sero-therapeutic treatment turned out to be inefficacious. Happily, while by the most diverse plans we were in vain searching for a method of treating tuberculosis by serum, a German experimenter, Behring, after studying the effects of the serum of refractory animals upon diphtheria, showed (in 1892) that this serum is wonderfully efficacious in the treatment of the disease. He applied the serum method of treatment not only to diphtheria, but also to tetanus, and, at first in animals and afterwards in man, he obtained results which were really marvellous. Gentlemen, you know the rest, and I need not tell you that this sero-therapeutic method, improved and popularised by Roux in 1894, is now a treatment without compare. The statistics on this head are absolutely conclusive. The mortality of diphtheria, which was 45 per cent., has fallen to 15 per cent. That means for the city of Paris alone an annual saving of about 1000 human lives; for the whole of France nearly 10,000 lives. We may take the same proportion for Italy, Germany, England, the United States, Canada, and Russia, and may estimate the number of infants which serum therapeutics snatch from death at about 50,000.

In other diseases the results of serum therapeutics have been much more open to criticism, and it would be necessary in order to arrive at a satisfactory conclusion to discuss them in detail. I cannot attempt to do this here, for it would be an abuse of your patience. I will content myself by venturing the opinion that serum-therapy has not said its last word. The organism is endowed with a marvellous power of resisting the poisons secreted by microbes. It sets to work in its turn to secrete counter poisons which neutralise the poisons secreted by the microbe. The antitoxins of the organism combat the toxins of the parasite, and in the future the art of serum therapeutics will be to seek in these resisting organisms the antitoxins fabricated by their cells.

Medicine and Experimental Science.

Thus on whatever side we turn we find that medicine has always been guided by experimental science. By experiment and by science it is compelled to march forward. This was true in the time of Harvey, for that immortal physiologist had to meet the opposition of physicians. This was true also in the time of Lavoisier, when by a few decisive experiments he proved the chemical nature of the phenomena of life. But how much more true is it at the present time since Pasteur has by experiment laid open a whole world, and has warranted us in conceiving the widest hopes for the future of medicine?

The parts of the man of science and of the physician are very different. The physician ought to be conservative, applying methodically the teaching and the precepts which he has received. He has no right to experiment upon his patients, or to permit human life or human suffering to be risked on fantastic theories. But the man of science ought to be a revolutionist. He ought not to be content with the doctrines which he has been taught. The opinion of the master ought to be but a light weight upon his mind. He ought to seek on every hand for facts which are new and even improbable. Darwin says somewhere that he had made the experiments of a fool, and often it is right to attempt that which appears contradictory to all the most received and classical opinions. Without this spirit of adventure, without this scientific daring which opens up new horizons there is no progress.

The task of the explorer or of the pioneer is not that of the physician. He ought to be careful to keep himself abreast of all scientific progress in order that his patients may have the benefit of it, but he cannot advance the progress of science, save within restricted limits. Having no right to experiment, he is almost powerless to solve the difficult problems which arise.

It is the duty of the chemists, the physicists, and above all the physiologists, to guide medicine into the new ways. They have not to take the heavy responsibility of a human life upon their shoulders, and nothing ought to check their audacity. You, gentlemen, have not the right thus to be audacious: you need prudence and moderation, and, convinced as I am of the power of experimental science, I still think that the applications which the chemists and the physiologists suggest to you should only be accepted with considerable caution. It costs us nothing, after a few experiments which have succeeded fairly well, to say to the physician, "Try that on your patients." You know very well that our responsibility is *nil*, and that the ancient axiom *primo non nocere*, an axiom which ought to be your strict rule of conduct, does not in any way apply to us. You see, therefore, that it would be unjust to make it a matter of reproach to physicians and surgeons that they have not made great scientific discoveries. This is not their mission. It is theirs to relieve human suffering, and to seek among new scientific truths that one which is most proper to relieve or to cure the sick.

Nor can I understand how any one should have wished to create an antagonism between medicine and science. To suppose that they are in contradiction is to show that we understand nothing about either the one or the other. It is not reasonable to assert that the one is superior or inferior to the other; they are different in their means and in their ends. They are mutually complementary, and both are equally necessary.

If I were ill most assuredly I would not seek the assistance of a chemist, or of a physiologist, and medicine is not to be learned from the books of Claude Bernard or of Pasteur. Clinical instruction is necessary, such as long observation of patients alone can furnish. Prophylaxis, diagnosis, prognosis, therapeutics are not to be learned in scientific books. Something else is necessary—observation, long, patient observation, the old Hippocratic observation, without which there can be no good physician. Young students must be guided in the examination of patients by experienced practitioners, and no one, I presume, would be guilty of the folly of proposing to replace the clinical ward by the laboratory.

But without laboratories the clinical department must remain incapable of scientific advance, and this condition of stasis is assuredly undesirable; for in spite of all the progress which has been made, much yet remains to be done. Are not tuberculosis and cancer, for example, the disgrace of medicine? I appeal to all medical men here present. Is there any one of you, gentlemen, who in the presence of such painful modes of death does not feel himself humiliated to the bottom of his soul by his powerlessness?

Well, this feeling of our present powerlessness against disease ought to stimulate us to work. The work to be done is enormous, and we must none of us grow weary of our task. We physiologists must seek new facts, we must seek and seek again, seek always without being afraid of the boldest hypothesis, and without putting any limit to our audacity, without troubling our heads as to the practical consequences which may flow from our discoveries, having only truth—divine truth—for our object. As for you, gentlemen, it is your duty to follow with the warmest interest both the general effect and the detailed results of biological discoveries in order to attempt to find some practical application for them. From this unceasing collaboration progress will be born. But it is necessary that men of science and physicians should both be animated with these two governing sentiments—faith in science and love of man.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE *Athenæum* says that a proposal is being considered to establish at Swansea, as a great manufacturing centre, a branch University College in association with either Aberystwith or Cardiff, as the Newcastle College is associated with Durham. The suggestion is that scientific and technical courses might be taken at Swansea in preparation for the Welsh University degree.

A SPECIAL course of instruction in electro-chemistry will be given during the coming session at the City and Guilds Central Technical College. The course will include practical instruction in electro-deposition, the use of the electric furnace, dynamos, transformers and accumulators. A great part of the time of the students attending this course will be devoted to electro-chemical research and the study of electro-chemical action. Candidates for admission will be required to submit evidence of having a general knowledge of physics and chemistry and of having been specially trained in one of these subjects.

A LONG article and a leader in yesterday's *Times* calls attention to the growth and present position of Higher-Grade Board Schools, of which there are about sixty now in the country, most of them containing over 500 scholars, while several have between 1000 and 2000. It is pointed out that schools of this kind are an organic growth, and have not come into existence, like so many technical classes, because a public body suddenly found itself endowed with money which it did not understand how to spend. Boys and girls are eligible for admission into the higher-grade schools after passing Standard VI. The course of instruction must include science, mathematics, drawing, manual instruction, English subjects, and at least one modern language. Science must be taught by means of laboratory instruction; and all subjects taught must be submitted to inspection. The course prescribed extends over four years, and during the first two years grants are not paid on individual successes in examinations, but are paid as capitation grants, the amount of which depends on the efficiency of the teaching, the school equipment, and the average attendance. The Department of Science and Art further insist that classes shall not be allowed to contain many more than thirty students, and for practical work they fix the absolute *maximum* at twenty-five. These rules have made it possible to give in higher-grade schools a thoroughly satisfactory general education, in place of the one-sided education that was formerly given. From their very birth higher-grade schools have had to encounter bitter and determined opposition. Opposition came in the first place from the ratepayers, but the main opposition comes now from small endowed schools, which are beginning to feel their competition, and from those persons who wish to see secondary education placed under county councils, and find that in large towns School Boards are already in the field. So far as the actual competition is concerned, it is, perhaps, to be regretted that a grammar school should be steadily emptied of its students to swell the numbers of an already overfull higher-grade school. When this happens there is, however, one way to stop it. Let the grammar school bring itself to that state of efficiency which has been forced upon the higher-grade school by the hostile public criticism it has had to meet, and the public inspection to which it has all along been submitted. This is the advice given both in the article and the leader in the *Times*. It is also pointed out that the fact that higher-grade schools have, in some places, half-emptied local secondary schools, so far as it is due to the better and more practical character of their education, is an object-lesson in favour of that organisation, and public inspection, of lower-grade secondary schools which educationists have so long desired.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 13.—M. A. Chatin in the chair.—On the permanent deformation of glass, and the displacement of the zero point of thermometers, by M. L. Marchis. An application of the theory of permanent deformations, due to M. Duhem, of which an account has previously been given.—On the electrolytic separation of nickel and cobalt from iron. Application to the estimation of nickel in steel, by M. O. Ducru. The solution of the sulphates of the metals is mixed with some sulphate of ammonium and excess of ammonium hydrate, and then submitted to electrolysis. The whole of the nickel, or cobalt, is deposited, together with a trace of iron. The latter may be determined by solution of the deposit in hydrochloric acid; and precipitation with ammonium hydrate, and a corresponding deduction made. Samples of steel are first dissolved in nitrohydrochloric acid, and then evaporated with excess of sulphuric acid. The test analyses given are very satisfactory.—The functions of the thyroid gland, by M. E. de Cyon.—On the respiration of *Carcinus mænas* (Leach), by M. Georges Bohn. The author has observed, in this species of crab, the power of reversing the direction of the circulation of water in the branchial chamber.

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