THURSDAY, JUNE 27, 1901.

STUDIES IN COMPARATIVE RELIGION.

The Golden Bough: a Study in Magic and Religion. By J. G. Frazer, D.C.L., LL.D., Litt.D. Second Edition. Revised and enlarged. Three volumes. Vol. i., pp. xxviii + 467; vol. ii., pp. x + 471; vol. iii., pp. x + 490. (London: Macmillan and Co., Ltd., 1900.) Price 30*s*. net.

WITHIN recent years few books have exercised more influence on the study of comparative religion than Mr. Frazer's "Golden Bough," the first edition of which appeared in 1890. Working in the main on the lines laid down by Prof. E. B. Tylor, he applied the results obtained from a prolonged study of the beliefs and practices of primitive races to explain the meaning and origin of a strange rule of an ancient Italian priesthood. Near the lake of Nemi in the Alban hills, at some distance from the ancient town of Aricia, stood a grove and sanctuary sacred to Diana, and the strange rule of the priesthood attached to the grove finds no parallel in classical antiquity. The priest, who bore the title of "King of the Wood," watched night and day with a drawn sword, always ready to defend his life against the attack of a possible assailant. A candidate for the priesthood had first to break off a bough from a certain tree in the wood, and, if successful, he was entitled to fight the priest in single combat; should he slay the priest he reigned in his stead until he in his turn was slain. Mr. Frazer's book takes its title from the tradition that the branch guarded by the priest was the Golden Bough which Æneas plucked before he attempted his journey to the realm of the dead. Put briefly, Mr. Frazer's explanation of the rule amounts to this: the King of the Wood was an incarnation of the tree-spirit, or spirit of vegetation, which was also inherent in the Golden Bough, or mistletoe, growing on the tree, probably an oak, in the Arician grove. The only way of preserving the tree-spirit from decay necessitated the priest's violent death; the divine life by this means was transferred to a suitable successor—that is to say, to the stronger man who should slay him. But in his character of a tree-spirit, the priest's life was bound up with that of the mistletoe on the tree; hence it was necessary for the slayer first to break the Golden Bough. The exposition of this theory furnished the thread on which Mr. Frazer skilfully arranged a series of exhaustive essays dealing with many phases of primitive superstition and belief.

In our review of the first edition of the book (see NATURE, September 25, 1890, vol. xlii. pp. 513 ff.) we described in detail the various steps in Mr. Frazer's argument, and we shall not, therefore, go over the same ground again, but rather confine ourselves to noticing the most important additions which Mr. Frazer has incorporated. The book has been considerably expanded, for it now consists of three instead of two volumes, and a rather smaller type has been used. The system of arrangement and the division into four chapters has been retained, but there are few parts of the work to which considerable additions have not been made. During the ten years that have elapsed since the publication of the first edition, most valuable researches have been carried on by Messrs. Spencer and Gillen in Central Australia, by Mr. Skeat in the Malay Peninsula, by Mr. van der Toorn in Sumatra, and by the late Miss Kingsley in West Africa, to mention but a few names among the growing band of practical anthropologists; and the store of new material thus collected has furnished Mr. Frazer with a host of fresh examples to illustrate his theory. Great advances have also been made in our knowledge of the ancient Egyptian and Babylonian religions, and Mr. Frazer has availed himself of the recently published works on these subjects. Such additions have considerably increased the subsidiary and illustrative portions of the book, but they only affect the main argument in so far as they furnish additional proofs and instances. Two sections, however, have not only been expanded, but have been recast and rewritten, and with these we propose to deal in greater detail. In the first edition a short section of a few pages was devoted to a description of primitive man and his conception of things supernatural; in the second edition this has been expanded into a regular treatise, in which Mr. Frazer for the first time formulates his theory of the relation of magic to religion. Again, in the first edition the author only hinted at the bearing which his researches might have upon some of the central tenets of the Christian religion; in the second edition he has worked out his theory in detail.

Speaking broadly, Mr. Frazer has come into line with the majority of anthropologists and students of religion in regarding magic and religion as totally distinct from one another, the former representing a lower intellectual stratum which has probably everywhere preceded the latter. When writing his first edition, Mr. Frazer tells us, he did not accurately define, even to himself, his notion of religion, and he was disposed to class magic loosely under it as one of its lower forms. He has now framed his definition of religion, not by collecting the opinions of the learned on the subject, but directly from his own study of the facts. Mr. Frazer's position among contemporary writers would ensure for any view he might propound the most careful study and consideration; we note with the greater pleasure, therefore, that his mature opinion on the relation of magic to religion does not necessitate the recasting of the theory at present in the field. In his opinion the movement of man's thought has, on the whole, been from magic, through religion, to science. In magic man depends on his own strength to meet the difficulties and dangers that beset him. He believes in an established order of nature which by certain actions of his own (*i.e.* magic) he can manipulate for his own ends. When he discovers his mistake and finds he cannot control nature as he believed, he ceases to rely on his own unaided efforts and ascribes to certain great invisible beings behind the veil of nature the far-reaching powers which he once arrogated to himself. Thus magic is gradually superseded by religion, and natural phenomena are believed to be regulated by beings who are like men in kind and are swayed by human passions, but are endowed by powers vastly superior to his. As time goes on this explanation in its turn proves unsatisfactory. The longer nature is studied the succession of natural events appears less and less variable and irregular.

"The keener minds," writes Mr. Frazer, "still pressing forward to a deeper solution of the mysteries of the universe, come to reject the religious theory of nature as inadequate, and to revert in a measure to the older standpoint of magic by postulating explicitly what in magic had only been implicitly assumed, to wit, an inflexible regularity in the order of natural events, which, if carefully observed, enables us to foresee their course with certainty and to act accordingly. In short, religion, regarded as an explanation of nature, is displaced by science."

We have here a sane and consistent theory of the progress of human thought, and we wish we had space to quote at greater length; for further details we must, however, refer the reader to the book itself.

In passing to the section which treats of "The Saturnalia and Kindred Festivals" we come upon more debatable ground. Here Mr. Frazer has expanded his theory of the general prevalence of the custom of killing a human god, so as to include, and to some extent explain, the crucifixion of Christ. We may say at once that we hold no brief for the orthodox view with regard to that event, and, if the evidence tended to prove that the crucifixion, with the mockery which preceded it, was not a punishment specially devised for Christ but merely the fate which annually befell a malefactor who played the part of a mock king during a sort of Saturnalia, there would be no reason, so far as we are concerned, why the theory should not be accepted. Mr. Andrew Lang, in the character of a champion of orthodoxy, has already made an onslaught upon Mr. Frazer, and we have no intention of following his example or of adopting his methods of controversy. But to our thinking Mr. Frazer has in this portion of his book been induced to abandon his excellent practice of following his evidence, and has considerably outrun it.

In his explanation of the rule of the Arician priesthood Mr. Frazer infers that at an earlier period one of the priests had probably been slain every year in the character of an incarnate deity. In his first edition the only parallel case he could cite was the custom of killing a human god annually in ancient Mexico. Now from a narrative of the martyrdom of St. Dasius, published by Prof. Cumont in 1897, it would seem that at the celebration of the Saturnalia the King, or Lord of Misrule, had not always been a mere clown, but that at one time it was the custom, after a riotous rule of thirty days, that he should put himself to death. This new piece of evidence Mr. Frazer justly claims as a striking confirmation of his theory with regard to the Arician priesthood, but it does not prove, or render likely, the extensive prevalence in the East of the custom of annually killing a human god which his theory of the crucifixion presupposes.

There is some evidence that during the late period of Babylonian history, after the Persian conquest, an annual feast took place in Babylon termed the Sacæa, which resembled the Saturnalia in that masters and servants changed places and a mock king presided over the revels. The evidence for the festival consists of a quotation by Athenæus from Berosus, while Dio Chrysostom, quoting probably from Berosus or Ctesias, adds the additional detail that the mock king was subsequently executed. Dr. Bruno Meissner has conjectured that the Sacæa may have corresponded to Zag-muk, the Babylonian festival of the New Year. We still know very little about the manner in which Zag-muk was celebrated, but, in spite of a difficulty of dates, it is possible that Sacæa was a late form of that festival. Moreover, the Jewish feast of Purim, the earliest references to which occur in Esther and the second book of Maccabees, was probably borrowed by the Jews during their captivity, and may well have been taken from the Babylonian Zag-muk, as Prof. Zimmern, of Leipzig, has suggested. There is no doubt that both Zag-muk and Purim were celebrated with feasting and revelry; but Mr. Frazer goes further, and would find in the account of the institution of Purim in the book of Esther traces of the slaying of a mock king such as, according to Dio Chrysostom, took place at the Sacæa.

It will be remembered that the book of Esther describes the rivalry between Haman, the vizier of Ahasuerus (probably a corruption of *Khshayārsha*, *i.e.*, Xerxes), King of Persia, and the Jew Mordecai; it relates how the Jews, when doomed to destruction through Haman's influence, were delivered by the Queen Esther and her uncle Mordecai, and how Haman perished on the gallows he had prepared for his rival. Prof. Jensen, of Marburg, has recently formulated a theory that the names Haman and Vashti are those of an Elamite god and goddess, and that Mordecai and Esther are the Babylonian deities Marduk and Ishtar; and, further, that the story reflects an antagonism between the gods of Elam and the gods of Babylon. Mr. Frazer accepts the identifications, and in the story of the death of Haman on the gallows sees a further reflection of the custom of slaying a man in the character of a god. He thinks that such human sacrifice formed part of the original rites of the feast of Purim, and was probably derived from some similar rite among the Babylonians. In the burning of effigies of Haman at the feast of Purim by the later Jews he sees a survival of this human sacrifice. The rite he explains, on lines already familiar to his readers, as a magical ceremony intended to ensure the revival and reproduction of life in spring.

In such ceremonies elsewhere the man-god dies only a mimic death and then rises again, or else he was actually slain and was thought to live in the person of a successor who took his place. In the Esther story Mr. Frazer suggests that Mordecai represents the second temporary king, who, on the death of his predecessor, was invested with the royal insignia and exhibited to the people as the god come to life again. In Vashti and Esther he sees the divine consorts of the mock kings during their brief periods of rule. In this way he explains the story of the struggle between Haman and Vashti, on the one side, and their doubles, Mordecai and Esther, on the other:

"Both pairs stood for the fertility of plants and perhaps of animals; but the one pair embodied the failing energies of the past, the other the vigorous and growing energies of the coming year."

In the original form of the rite from which Mr. Frazer supposes the feast of Purim to be derived, he suggests that the Babylonian king was the actual victim who was put to death each year, but that subsequently a substitute was always found in one of his sons, or a slave, or a malefactor. His period of rule was also curtailed from a year to a few days each year.

Now the details of the crucifixion present some resemblance to the treatment of the mock king in the Sacæa. Both victims were clothed in fine raiment and crowned as kings, and afterwards scourged aud crucified. This, Mr. Frazer thinks, is not a chance resemblance. The Jewish feast of Purim may have been derived from Zag-muk, which in turn may possibly be identified with the Sacæa; and he suggests that the Jews in the time of Christ may have every year at the feast of Purim compelled a condemned criminal to play the part of Haman and be put to death, in the same way as their later descendants destroyed effigies of him. Briefly, Mr. Frazer's theory is that Christ was put to death as one of these yearly victims. That the crucifixion took place at Passover, *i.e.* a month after the Feast of Purim, he thinks may be explained by supposing that Christian tradition for purposes of edification shifted the date of the crucifixion from Purim in order to make the sacrifice coincide with the annual sacrifice of the Passover lamb. He offers the alternative suggestions that the Jews may have sometimes celebrated Purim at about the time of the Passover (*i.e.* in Nisan) in consequence of its derivation from the Babylonian Zag-muk, which was held in Nisan; or, finally, the Jews may have spared the victim of the feast of Purim for one month, when his death would occur at Passover. Thus, according to Mr. Frazer, Christ was crucified and Barabbas was released as part of the passion-play performed each year by the Jews at Purim. They took the parts of Haman and Mordecai respectively, and at the end of the performance the one who played Haman was crucified, and the other, who personated Mordecai, was allowed to go free. Following out his theory, Mr. Frazer suggests that the name Barabbas, "Son of the Father," was not the name of an individual, but was the title given to one or both of the actors in the play. Similarly, the description of Christ's triumphal ride into Jerusalem before his death, and the account of the raid he made afterwards upon the stalls of the money-changers in the temple, he thinks may perhaps be traced to those arbitrary rights over property which it has been customary to accord to such temporary kings during their brief period of rule. The hero of the drama, in fact, may have been "no more than a moral teacher whom the fortunate accident of his execution invested with a crown not merely of a martyr, but of a god."

Such is Mr. Frazer's theory, and we confess to feeling that, unlike the rest of his book, this section contains a great deal of theory and very little evidence. That the rites of the late Sacæa were identical with those of the earlier Babylonian Zag-muk is pure assumption; and that a Babylonian king was at one time annually slain is unsupported by any evidence, whereas had this been the case the custom must have left some trace in the Babylonian literature. Prof. Jensen's identification of the principal personages mentioned in Esther with Elamite and Babylonian deities is, to say the least, a little fanciful, and still more fanciful is Mr. Frazer's improvement on his theory; it is hard to recognise in the story a reflection of a passion play. Finally, the question of dates is a real difficulty of which not one of Mr. Frazer's alternative theories successfully disposes. After careful study we think it easier to explain the resemblance of Christ's crucifixion to the rites of the Sacæa as the result of coincidence rather than to accept the artificial theory we have summarised. Moreover, with a strange absence of logic Mr. Frazer claims that his theory sheds "fresh light on some of the causes which contributed to the remarkably rapid diffusion of Christianity in Asia Minor"; as a matter of fact, it does the reverse. The political significance of Christ's martyrdom and the prominence it consequently gave his following form the simplest explanation of the rapid spread of Christianity. The more ordinary and normal the crucifixion is represented the harder it is to understand the problem; Mr. Frazer's theory reduces the crucifixion to an annual event.

We have dealt in some detail with the two chief novelties of the second edition of the work; our criticism of one theory, however, should not be taken as detracting in any way from the general value of the book, which will always form a storehouse of facts for the student of religion, and which will surely influence for many years the work of those who concern themselves with that wide and attractive field of study.

THE ISLAND OF CELEBES.

Über die geologische Geschichte der Insel Celebes auf Grund der Thierverbreitung. Von Dr. Paul Sarasin und Dr. Fritz Sarasin. Pp. vi + 169; 15 plates. (Wiesbaden: Kreidel, 1901.)

THE island of Celebes, as is well known, is comparable in a metaphorical sense to one of the floating islands of antiquity; it has not definitely come to rest in either the Australian or the Oriental region. By some authorities its marsupial inhabitants are held to outweigh in importance its likeness in other respects to the islands of the Malayan archipelago, and it is associated with Mr. Sclater's Australian region; others, again, place it as definitely with the Oriental region; while its anomalous and intermediate character has led not a few to fatal hesitation and to consequent abandonment of the problem. The authors of the volume before us dismiss at once, and with some brusqueness, all consideration of this matter. The chief problem of geographical distribution is for them not "whether Celebes belongs to the Oriental or to the Australian region, but what are the land connections, and of what epoch, which must be assumed to account for the condition of its fauna to-day?" This attitude of mind shows a healthy reaction against the elaborate method adopted by many zoogeographers of late years. The detailed planning and plotting out of the globe into a complicated series of regions, subregions and provinces is not, in the opinion of the present writer, of great usefulness save in so far as it allows of a rapid and perhaps graphic method of indicating the range of a particular animal. The two authors proceed further to observe that it is better to select, for the purposes of such problems as are presented by Celebes, species and not genera of animals; and this on the perfectly reasonable grounds that while the limits of genera are most diversely regarded, there is not, at least, so much difference of opinion as to the limits of a species. They are thus a safer indication of both likenesses and differences in two faunas. Mr. Sclater, some years ago, proposed the term of "lipotype" to express a negative state of affairs; a genus or species which was, as it were, unaccountably absent from a given region was thus denominated.

There is no doubt that this expression was wanted and that it did emphasise important zoogeographical fact. Nevertheless, it must be used with care, especially with regard to smaller and less conspicuous creatures. The Drs. Sarasin instance the case of the land planarians of Celebes. It was written so recently as 1891 that not a single species of this group of Platyhelminthes had been found in Celebes. Now we are acquainted with quite a number of forms, so much so that Celebes is the second richest island of the whole Malayan archipelago in these worms. We are glad to notice that the authors carefully distinguish between artificial introduction of species and introduction by natural means. To this matter attention has not, perhaps, been sufficiently drawn, and the wide range of many small creatures which has been used as an argument for their antiquity and has been generally made use of by the zoogeographer has not always the real value that has been attached to it. After due sifting of such fraudulent claimants to indigeneity the authors are, roughly speaking, disposed to do what has been mocked at—to demand a continent to explain the range of a beetle. Avoiding exaggeration, we can assert that the authors are not at all impressed by the floating log *deus ex machinâ*; they think that similar inhabitants on opposite sides of a sea generally imply a former land connection.

It will be noted from the few observations made that the authors preface their detailed consideration of the fauna of Celebes and neighbouring islands with some remarks of a general nature, which might perhaps have been rather more expanded if the work had not been of so special a character. The animal groups made use of by the authors are chiefly the molluscs, reptiles and amphibians; birds, mammals and land planarians are not neglected. The fact that there are more peculiar species of molluscs than of reptiles and amphibians is commented upon; this the authors attribute to the greater mobility of the two vertebrate groups. In discussing all zoological characteristics of Celebes it must be borne in mind, as is duly pointed out on p. 128, that the island itself first rose from the waves after Eocene times, for a great mass of the solid rock of which it is built is Eocene chalk. The view of its subsequent history which the fauna appears to indicate is that it first showed itself above the water in the Miocene and that during the Pliocene it was in connection with neighbouring islands, from which it became subsequently and at different times detached. It is justly described, therefore, as a "fragment of a Miocene continent." One important exception, however, exists to the statement that Celebes has been in the past in connection with the other islands of the surrounding seas. The authors point out that there is not a single species of animal known to be common to Celebes and Borneo and not at the same time found in some of the other islands; this, as is justly inferred, seems to indicate that Celebes can never have been connected by a land bridge with Borneo directly, though, of course, it probably was indirectly by way of Java, on the one hand, and possibly (though the authors think not) the Philippines on the other. The Macassar strait thus represents a tract of ocean which has been water before and since the appearance of Celebes upon the earth's surface. On the other hand, the supposed deep channel on the south intervening between Bali and Lombok is, as it appears from Prof. Max Weber's soundings, to be given up, since the greatest depth then ascertained to exist was merely 312 metres. This volume is of extreme interest as a detailed attempt to reconstruct from a comparison of faunas the past geological history of a group of islands. It is abundantly illustrated with maps, and concludes with an historical review of the literature of the subject and a list of memoirs and books.

F. E. B.

ENGINEERING EDUCATION.

Proceedings of the Eighth Annual Meeting of the Society for the Promotion of Engineering Education held in New York City, July 2–3, 1900. Vol. viii. Pp. xxviii + 377. (New York: Engineering News Publishing Company, 1900.) Price 2.50 dollars.

WHEN technical education is so much in the air, and so many consider that it is a cure for all our industrial troubles, it is interesting to see what another nation thinks of its own system of education. In America there exists a society for the promotion of engineering education, and we have the pleasure of reading their eighth volume of *Proceedings*—that of last year. The members of this association are those who are, or have been, engaged in responsible positions in the work of engineering instruction. There is a regular meeting for several days once every year, the whole of the papers which are read dealing with education as applied to industry.

The association seems to be most prosperous, both financially and in point of numbers; it is clear that meeting together of teachers is most useful to both teachers and students, and it is to be hoped that in this country a similar society may be formed, which would do much to educate public opinion as to what technical education exactly means. At present very few people understand what is wanted to be taught and whom to teach it to; an individual, even of the most impressive powers and personality, cannot speak with the same authority as a society which has only one end, namely, to improve our educational methods.

The presidential address of Prof. Ira D. Barker, dealing with the position of engineering education in the United States at the end of the century, is most instructive in showing what a strong hold technical instruction has on the other side of the Atlantic.

At the end of 1899 there were eighty-nine institutions offering full courses in engineering, in some cases seven different courses being open to students, the numbers attending full courses being 9679; of these colleges no less than 98 per cent. require the four years' course before graduation.

These schools must not in any way be considered as falling into the same category as our technical schools, which mainly address themselves to evening work for the artisan class. No doubt our technical schools do excellent work, but they in no way give that thorough and systematic instruction which is given in the American colleges, which do not wish to produce workmen, but to train successful leaders of industry. The trade school, which seems to have become inevitable in all countries under the stress of modern industrial competition, is evidently making its way in America, but, unlike us, no attempt is made to teach a boy a trade in his spare hours during the evening, but attendance is required during his entire time. The course really forms a part of the high school curriculum, and, while not developed to the same extent as in Germany, it is clear that Americans look to some such school to give that training which was in olden days given to the apprentice, but which will soon have become impossible to acquire in a modern works.

Perhaps the most interesting paper in the *Proceedings* is one by a committee on American industrial education. Great prominence is given to the manual training method, not only for kindergarten work, but for all grades of education up to the highest; as is there stated, the system is costly, but the results are said to be calculated to astonish those who have never seen the manual training system in operation.

The agricultural and mechanical colleges, founded in the first instance by land grant bills, are evidently the backbone of American education as regards applied science. Some colleges, such as Cornell, have developed in all directions, while others have confined their scope to purely practical subjects.

In all cases the instruction is based on a wide basis of those pure sciences which are the foundation of all technical knowledge. The Americans go further than we do, and give up a part of the course to purely literary subjects in order to give a broader education.

The correspondence technical schools are probably peculiar to America and are of quite a recent date; they are purely private concerns, which offer to give complete instruction by a course of papers. As the committee remark, the majority of students who commence soon drop the courses, but the convenience of learning by post is considered so great that these correspondence classes will probably become permanent.

The night school system is condemned by the committee in a most positive manner. The learner starts to learn after a heavy day's work, and after the classes are finished mind and body are alike exhausted.

No systematic course of study is possible owing to lack of time, while the whole atmosphere of the school is said to be very far from stimulating and encouraging. We are quite in agreement with this committee on this subject, and wish that people would not place so much reliance on the work of evening classes.

We conclude with an extract from some remarks made by Prof. Alderson, of Lafayette, Miss.:—

"Those who have had an opportunity to look into this matter probably know full well that to-day the industrial decadence of England is due to her failure to recognise the proper status of engineering education."

Such remarks are not pleasant reading, but often a dose of bitter truth is beneficial. Let us hope that it may not be too late for the warning to be of service.

F. W. BURSTALL.

OUR BOOK SHELF.

Chemical Technology; or, Chemistry in its Applications to Arts and Manufactures. Edited by C. E. Groves and W. Thorp. Vol. iii. *Gas Lighting.* By Charles Hunt. Pp. xviii+312. (London: J. and A. Churchill, 1900.) Price 18s.

THIS, the third volume of a well-known work on chemical technology, gives a history of the manufacture of gas and its application to the purposes of illumination. After a short historical introduction, about three-quarters of the remainder of the book is occupied with a description of the mode of manufacture, purification and distribution of coal gas as carried out in this country. The consideration of gas burners then takes some fifty pages, the questions of the testing, analysis and determination of the heat of combustion of gas occupying about twenty pages. The apparatus used in the manufacture of coal gas is described in great detail, chapters being devoted to the construction and use of retorts, furnaces (several regenerative furnaces being described in this section), stoking machinery, condensers and scrubbers, purifiers, the measurement and storage of gas—the numerous forms of gasholders being very fully given—governors, distributing mains and pipes, and gas meters.

The mode of treatment throughout is that of an engineer, or rather a gas engineer, writing for gas engineers, and as representing the wide experience of the author in this respect the work will doubtless be found necessary on the bookshelves of every manager of a gasworks. The only criticism which may be offered in this respect is that the question of water-gas manufacture and distribution is not treated with the fulness which the growing importance of the subject deserves, a defect which may perhaps be attributed to the fact that it is only within the last year or two that public attention has been drawn to this subject by the agitation of certain public authorities against the use of this gas, and the subsequent appointment of a committee of the Board of Trade to consider the matter. From the absence of any mention of this, and from other indications, it is clear that the book was completed some two years before the date of publication. Thus the limits of sulphur impurity allowed in the metropolis are incorrectly stated, and no mention is made of the complete alteration in the method of testing London gas prescribed by the London Gas Referees in 1898.

But a more serious objection is the mode of treatment of the subject as a whole. As one of a series of chemical handbooks, it is natural to expect that the subject would be treated from a chemical, or at all events from a scientific, as opposed to an empirical, point of view, and this is by no means the case. The growth of gas manufacture in this country has been essentially empirical, and, although dealing with a chemical manufacture, has been developed almost exclusively by engineers without any special chemical knowledge. This is faithfully mirrored in the work under notice, in which mechanical details are given with minute accuracy, but chemical details are alluded to very briefly. Incidental references are made to the modes of analysing coal gas at various stages of its purification, although even here preference seems to be given in gasworks to rough and empirical apparatus. It is noteworthy that whilst the title of the book is "Gas Lighting," the question of photometry is altogether omitted; and although, as mentioned in the earlier chapters, the temperature at which the coal is distilled is of supreme importance as regards its quality and quantity, no mention is made of the use of any form of high temperature thermometer, nor, judging from the present work, does the pyrometer seem to be regarded as an essential part of the equipment of a gasworks.

There is still room for a work on coal gas which shall treat of the subject from a scientific as opposed to the empirical standpoint.

Elements of Quaternions. By Sir W. Hamilton. 2nd edition. Edited by C. J. Joly. Vol. ii. Pp. liv+502. (London: Longmans and Co., 1901.) Price 21*s.* net.

THIS being the second volume of the reprint of a book that has become classical, and is known, by reputation at least, to all mathematicians, it is unnecessary to review it at much length. A comparison, however, seems to be called for between the work of the master and that published by his great disciple, Prof. Tait, since the first edition of the "Elements" made its appearance. The methods of treatment adopted differ radically. Prof. Tait's book is "essentially a working one," and for the most part contains only those formulæ that are necessary to a student when he commences the study of quaternions, and will afterwards be his working formulæ for general use. Sir W. Hamilton's book, on the other hand, aims at completeness. It gives fifty-three transformations for the vector of torsion of a curve in space, and treats the whole of the theory of curves and surfaces with the same elaboration! This wealth of methods and formulæ, which will only confuse the student who wishes to learn quaternions merely in order to apply it in his investigations in physics, &c., makes the book indispensable to the student who studies the subject for its own sake, or who wishes to deepen or consolidate the knowledge of it that he already possesses. Hamilton passes over statics and rigid dynamics quickly, but he treats dynamics and Fresnel's wave surface with his usual fulness.

About a quarter of this volume is occupied by notes by Prof. Joly. Among these are some on the invariants of linear vector functions, on the tri-linear function, and on the kinematical treatment of curves and surfaces. There is a long note on the operator ∇, a symbol which Hamilton does not use in the "Elements." These notes are very valuable, both because they bring the work up to date, and because they are very suggestive of fields for original investigation. We regret that mention is not made of the properties of the quaternion that is the sum of the vector and scalar potentials in the case of irrotational fluid motion, &c., and that several useful words, such as "curl," "convergence," "vector potential" are little used. No mention is made of the notation (f, g, h) for a vector.

A difficulty under which quaternions at present suffers is that, on the one hand, a worker in a branch of applied mathematics does not care to publish papers in quaternion notation for fear that few will understand him; and, on the other hand, that the lack of such papers discourages the study of quaternions. The notation just referred to seems likely to afford a convenient bridge between Cartesians and quaternions. An investigation of the electromagnetic wave surface by Prof. Tait is quoted in a footnote. It might have been added that the surface was first found by Heaviside. The omission is no doubt due to Heaviside's use of vector algebra, but it is perhaps allowable to consider the latter to be quaternions written in a modified (but not improved) notation. H. C. P.

Our Country's Shells and How to Know Them: a Guide to the British Mollusca. By W. J. Gordon. Illustrated by A. Lambert. Pp. vii + 152. Thirty-three coloured plates. (London: Simpkin, Marshall, Hamilton, Kent and Co., Ltd.) Price 6*s.*

COLLECTORS of British shells will find this volume very useful for reference. The plates include coloured pictures of all our mollusca having shells, drawn life size in most cases, and also representatives of each genus without shells. Analytical tables are given to facilitate identification, and there are chapters on the habits and structures of the mollusca. If the collection of shells induces students to study the characteristics of the living animals, the book will be a means of education in natural history as well as a convenient reference manual.

LETTERS TO THE EDITOR.

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Our Mountain Seclusion.

IN these days of continuous railway expansion it is only natural and desirable that our mountain solitudes should be made accessible to the general public. But obviously this praiseworthy object should not be attained by the destruction of the very seclusion which it is proposed to reach. A line of railway, with its cuttings, tunnels, embankments, stations, smoke and noise, will carry us much more swiftly and conveniently into a remote glen than the older and quieter modes of locomotion, but we then find that the charm of loneliness which used to give the glen its special fascination has disappeared. Where this transformation is absolutely necessary for the general benefit of the public we must submit to it, though with a sigh. But where the necessity or even the advantage may be disputed, surely the beauty or grandeur or solitude of untouched and unspoiled nature ought to be allowed to have a potent influence in the decision of such matters.

I have just heard of an assault at present being waged against the sanctities of Snowdon, and though it may be impracticable to ward off or mitigate that assault, and possibly too late, even if originally practicable, the attention of all lovers of scenery and of all geologists may well be drawn to it. A bill which has been introduced into Parliament for the construction of the Portmadoc, Beddgelert and South Snowdon Electric Railway, or Tramway, has passed the House of Lords and the Examiners in the House of Commons. If the line is ultimately sanctioned it will greatly lessen the quiet beauty of one of the loveliest and most secluded scenes in Britain—the easily accessible valley on the south side of Snowdon. I understand that, as the result of pressure, the Company has given way with reference to a proposed embankment in the Pass of Aberglaslyn, and will content itself with a brief disappearance in a tunnel. But geologists will learn with vexation that one important part of the scheme consists in the embanking of that picturesque mountain tarn, Llyn Llydaw, for the purpose of obtaining water-power. I need not refer to the special interest and importance of this lake-basin in questions of glacial and physiographical geology. Though it has long been studied, it has not yet yielded up all that it has to tell in these departments of science. But the transformation proposed to be effected by the company will silence it for ever by destroying the evidence which it can now afford.

Can nothing be yet done to save this geological sanctuary from the vandalism of the modern company promoter?

June 22. ARCH. GEIKIE.

The National Antarctic Expedition.

THERE is one allusion in the article on the above subject last week which calls for a few words from me. I refer to the first introduction of the word "civilian." Through the kindness of a friend I have recently had the opportunity of seeing a copy of the agenda. The agenda correspond with the minutes, and the word "civilian" is used in both. I had myself forwarded the motion concerning the scientific leadership to the secretary to be put on the agenda, and the word "civilian" certainly had no place in my communication.

At the meeting I moved, and Prof. Herdman seconded, the motion in the terms of my original communication, and neither of us noticed the change on the agenda paper.

We must therefore plead guilty to some carelessness and inattention; but the argument in my letter to the Fellows of the Royal Society is not seriously affected. An important change, exceeding the instructions drawn up for the guidance of the Executive Committee, is not, on any reasonable view, properly introduced by a single word which appears in the agenda and is not noticed or used by the mover and seconder of the motion. So important a question of principle obviously demanded very special discussion.

June 22. EDWARD B. POULTON.

Stress—Its Definition.

THE important word *stress*, denoting a fundamental conception in dynamics, is one as to the meaning of which no haziness or doubt ought to be permitted by the scientific community.

In your review of Prof. Gray's "Physics," the reviewer criticises the use made of the word in question, and makes the statement: "Strictly a stress is measured by the force applied per unit of area; it has the dimensions of force divided by the square of a length. . . ."

No authority is quoted to justify this statement. Does such authority exist? On collating the statements regarding the meaning to be attached to the word in some of the most authoritative works in the language, I have found a considerable want of agreement.

Going back to Rankine, who is credited with having introduced the word *stress* as a technical term into mechanics, we find the following paragraph in his paper "On Axes of Elasticity and Crystalline Forms" (1855):

"In this paper the word *Strain* will be used to denote the change of volume and figure constituting the deviation of a molecule of a solid from that condition which it preserves when free from the action of external forces; and the word *Stress* will be used to denote the force, or combination of forces, which such a molecule exerts in tending to recover its free condition, and which, for a state of equilibrium, is equal and opposite to the combination of external forces applied to it."

Again, in his "Applied Mechanics" (1860), we find, in § 86:

"*Stress, its Nature and Intensity.*—The word STRESS has been adopted as a general term to comprehend various forces which are exerted between contiguous bodies, or parts of bodies, and which are distributed over the surface of contact of the masses between which they act. The INTENSITY of a stress is its amount in units of force, divided by the extent of the surface over which it acts, in units of area."

Then, in § 87, Rankine classifies three kinds of stress, (1) *Thrust or Pressure* (2) *Pull or Tension*, and (3) *Shear*, or *Tangential Stress*.

Further, in § 96: "*Internal Stress in General.*—If a body be conceived to be divided into two parts by an ideal plane traversing it in any direction, the force exerted between those two parts at the plane of division is an *internal stress*."

Clerk Maxwell, in "Matter and Motion," Art. 37, says: "The mutual action between two portions of matter receives different names according to the aspect under which it is studied, and this aspect depends on the extent of the material system which forms the subject of our attention.

"If we take into account the whole phenomenon of the action between two portions of matter, we call it Stress. This stress, according to the mode in which it acts, may be described as Attraction, Repulsion, Tension, Pressure, Shearing Stress, Torsion, &c."

Again, in Art. 101.—"Stress.

"The next step in the science of force is that in which we pass from the consideration of a force as acting on a body, to that of its being one aspect of that mutual action between two bodies, which is called by Newton Action and Reaction, and which is now more briefly expressed by the single word Stress."

Thomson and Tait's "Natural Philosophy" (1867), Art. 658 (referring to the theory of elastic solids). ". . . the forces called into play through the interior of a solid when brought into a condition of strain. We adopt, from Rankine, the term *stress* to designate such forces, as distinguished from strain defined to express the merely geometrical idea of a change of volume or figure."

Thomson (Kelvin) in the 9th edition of the "Encyclopædia Britannica," article "Elasticity": Mathematical Theory, Chap. i. "Def. A stress is an equilibrating application of force to a body."

Tait, in "Newton's Laws of Motion" (1899), Art. 45:

"A pair of equal and oppositely directed forces, acting in one line, is a particular case of what is now called a *Stress*. The stress along a stiff rod (necessarily the same across every transverse section) may be either a *Thrust* or a *Tension*, that along a string or chain can be a *Tension* only. [But the term stress, in its widest signification, means *any* system of equilibrating forces.]"

"In a fluid the stress at any point is generally what is called *Hydrostatic Pressure*, whose characteristic is that the stress is the same across a small given plane area. . . . In all these cases the stress is measured by the amount per unit area of the surface on which it is exerted."

Love, in "Theoretical Mechanics" (1897), Art. 122, defines the stress at a point A across a plane interface passing through A, as the force per unit area exerted across a small area whose centroid is A.

From the preceding quotations there would seem to be a double ambiguity in the present usage of the word *stress*.

Firstly, it may be used to denote the whole mutual action between two portions of matter, A and B, say, in which case it would be specified by stating the force or system of forces exerted either by A upon B, or by B upon A; or it may be used to denote the *force per unit area* exerted by A upon B. The latter is clearly less widely applicable (torsional stress, *e.g.*, cannot be reckoned per unit area), and corresponds to what Rankine calls *intensity of stress*, or what is by some teachers appropriately named *unital stress*.

Secondly, the term *stress* may be defined as in the "Elasticity" article in the Encyclopædia to be an "equilibrating application of forces," or, as by Maxwell, to be the complete phenomenon including the "Action and Reaction" of Newton's Third Law of Motion.

To my mind there can be no doubt as to the greater usefulness of the latter definition, even though the former may be more consistent with some of Rankine's statements on the subject. It will be noted that in my quotation from Prof. Tait's work there seems to be a vacillation between the two meanings (what is meant there by "stress across a transverse section," or "stress across a small plane area"?), though he explicitly adopts the former alternative; and in the paragraphs of "Thomson and Tait" immediately following that quoted above there seems to be a similar shifting of ground in applying the term, while Maxwell's use of the word is consistent with his clear definition. This in itself argues strongly for the Maxwellian use of the word. Besides, the "equilibrating application" definition would seem to leave us in the lurch when we wish to name the internal forces of bodies not in equilibrium. And all who have had much experience in teaching dynamics to beginners must appreciate the help which the word in its Maxwellian sense affords in getting the student to see the difference between reaction and equilibrant, and to stop asking one such conundrums as "If action and reaction are equal, why does a body move?" And of course it is precisely the beginner for whose benefit we should take the trouble to be consistent in the use of words.

Let me conclude by offering the following suggestions for what they are worth:—

(1) Let the word "stress" be defined and used as in Maxwell's "Matter and Motion."

(2) Let "unital stress" or "unital stress at a point across a plane" be used as defined in §122 of Love's "Theoretical Mechanics." R. F. MUIRHEAD.

Glasgow, June 4.

I HAVE to thank the Editor for his courtesy in allowing me to see Mr. Muirhead's interesting letter. I quite agree that the meaning attached to the word "stress" by eminent writers during the fifty years from the time of Rankine to the present day has varied. At the same time, I observe that the only two definitions of the "measure of stress" which are quoted are of recent date, and both state clearly that a stress is measured by the force per unit area, though I find this same definition in Thomson and Tait, 1867 edition, Art. 661, a few lines below the quotation given by Mr. Muirhead. I think, then, I may claim sufficient authority for my statement, "Strictly a stress is measured by the force applied per unit of area," and for the doubt which I expressed as to the desirability of introducing the word "stress" as practically synonymous with "force" in a discussion of Newton's second law of motion.

While I share Mr. Muirhead's regret at the limitation thus imposed on the meaning of a general term "stress" as indicating the mutual action between two bodies, I hardly think his suggestion to distinguish between "stress" and "unital stress" will meet the case. REVIEWER.

Hybrid Oochromy, with a Note on Xenia.

IN a note on "Telegony, Xenia and Hybrid Oology,"[1] which appeared in *Natural Science* (vol. xiv. p. 394, 1899), I introduced the last-mentioned term to denote a singular phenomenon

[1] At the request of the editor I have altered the term hybrid oology to hybrid *oochromy*, which I agree is in many ways better, except that it would seem to refer to the coloration of the egg to the exclusion of its microscopic structure.

said to have been observed in birds, viz., that when a hen is fertilised by a cock of another kind the resulting egg is contained in a shell tinted, more or less, like those laid by the cock's own breed. At the time, I must confess, I was rather inclined to doubt if it did really occur, or if it were not a simple reversion, or a mistake, when my attention was drawn still closer to the subject by a friend who had kindly offered to assist in obtaining, if it were possible, additional proofs of telegony by first crossing a canary hen with a greenfinch cock and then returning her to her own breed. This was done, and resulted in three eggs being laid to the greenfinch. Their shells were all tinted more like the eggshells of a greenfinch than those of a canary. Two of these eggs were afterwards found to be infertile. This showed that the alteration in the tint of the eggshell had nothing to do with the nature of the fertilising spermatozoon. But the occurrence of hybrid oochromy could not be said to have been proved, for there is very little difference in the tinting of the eggshells of a canary and greenfinch, and I do not know whether the canary was purely bred or not.

I was thus anxious to find out for certain whether or not such an occurrence was possible. I therefore obtained three black Minorca hens, which had come of stock that had been purely bred for the last twenty years. The Minorca breed is the oldest variety of the famous Spanish fowls, of which the origin seems older than the recollection of it ![1] These three Minorca hens I penned up alone for more than four weeks, during which time thirty-two eggs were laid, and the shells of all of the later ones were of a very pure white colour.

The reason I had kept them alone for so long a time was that I required eggs entirely free from the intervention of any cock, and the commonly accepted opinion of poultry fanciers seemed to be that a period of nearly three weeks was necessary for the complete extermination of spermatozoa. However, to prevent any mistake, at the end of this time three eggs were artificially incubated for a period of forty-eight hours at the Durham College of Science, and they proved quite infertile.

After having thus demonstrated that the Minorca egg is contained in a pure white shell, I introduced into their pen a buff cock of the Cochin China breed, a breed famous for the brown with which its eggshells are tinted. The second egg laid after its arrival in the pen was provided with a shell of a very decided brown tint, and among a dozen or more laid within the succeeding two or three weeks, the shells of several were of a faint brown tint.[2] I was, however, unable to observe any difference in the microscopic structure of the eggs, such as is described by Herr von Nathusius. (See "Dictionary of Birds," by A. Newton, p. 190.)

This remarkable case appears to me to be an almost incontestable proof that hybrid oochromy does, at times, occur, as the only other way for accounting for pure bred black Minorca hens laying brown tinted eggs would be that they were reverting to some brown-egg-laying ancestors, a very unlikely supposition when we remember the age of the breed.

The next question to answer is—How does hybrid oochromy take place? I feel quite convinced, both from my own observations and those with the above-mentioned canary, that the tint of the eggshell is not, and cannot be, affected by the nature of the fertilising spermatozoon, and so we must turn our attention to the spermatic fluid, the chemical properties of which, acting in conjunction with those of the products of the shell-gland, will probably be found to be sufficient to cause this change of tint.

Hybrid oochromy has, in company with a closely associated phenomenon in another kingdom (I refer to Xenia), often been referred to as a case that cannot be explained by the Weismannian theory of heredity, *i.e.* the continuity of the germ-plasm. If the above explanation (and I can suggest no other) of hybrid oochromy should be proved to be correct, it is easily seen to be merely a chemical change and wholly apart from the phenomena of fertilisation. In the same way I should think it is very possible that xenia might be found to be not unconnected with the conjunction of the male and female elements forming the endosperm. It doubtless will be shown before long whether or not these two attempted explanations be correct. They will, I hope, however, tend to lessen the opposition to the Weismannian theory by showing how a fact which, at first sight, appears absolutely antagonistic thereto is found to be in complete accordance with it. It also shows what a deep effect may be induced in living organisms by the interaction of the chemical products of their glands.

I must here take the opportunity of expressing my best thanks to the Durham College of Science, Newcastle-on-Tyne, for allowing me the ground, &c., on which to conduct the experiment. G. P. Bulman.

Newcastle-on-Tyne.

[1] "The Poultry Book," by Lewis Wright. Popular edition, p. 340.

[2] Since writing the above I have incubated two of these eggs and found them fertile. At first sight this would seem to contradict the explanation given, but although I hold that fertilisation is not necessary, it certainly may take place in some cases.

The Swimming Instinct.

I have just tested the inherited powers of swimming in newly hatched pheasants. I find that when placed in tepid water, at the age of about thirty hours, they swim easily with well-co-ordinated leg-movements and show very little signs of distress.

C. Lloyd Morgan.

University College, Bristol, June 24.

RECENT SCIENTIFIC WORK IN HOLLAND.

Beginning with that which is of most general importance, we draw attention to the recent work of Prof. Hugo de Vries, of Amsterdam. Prof. de Vries, who is well known as a botanist and biologist and whose name is familiar to those acquainted with the history of modern chemistry, has just published the first part of a book entitled "Die Mutationstheorie. Erster Band. Versuche und Beobachtungen über die Entstehung von Arten im Pflanzenreich" (Leipzig: Veit, 1901), containing, as the title indicates, the account of a series of observations on the formation of new species in plants. Starting from the fact, well known to florists, of the appearance of "single variations" in their flower-beds, de Vries has been trying to find wild flowers which would show the same phenomenon. Of the 100 species investigated only one appeared to possess the property which was looked for, the *Œnothera Lamarckiana*, originally from America, but at present growing wild in Holland. Now about ten years ago de Vries transferred specimens of this plant to the botanical gardens at Amsterdam, and up to date he has studied as many as 50,000 of its descendants.

Of these 50,000 about 49,200 were in no respect different from the original patriarchal *O. Lamarckiana*, showing no tendency towards gradual change in any special direction, but only the common small fluctuating "variations" as regards size and appearance on either side of a normal, in fact resembling in that respect other plants and animals which are left to themselves without being interfered with.

Quite otherwise the 800 other plants. None of these, although appearing spontaneously, could be said to be representatives of the species *Lamarckiana*, from which they were descended. De Vries arranges them in seven distinct species, viz. 1 of *O. gigas*, 56 of *O. albida*, 350 of *O. oblonga*, 32 of *O. rubrinervis*, 158 of *O. nanella*, 221 of *O. lata* and 8 of *O. scintillans*. Now comes the crucial question of the whole investigation. What right has de Vries to look upon the differences between these seven species and the original species as being of a different order from the variations between the specimens of each species, and what entitles him to call these differences *mutations* as opposed to variations? The answer is this: a representative of these new species produces descendants the majority of which unmistakably belong to the same species as itself. Not all the new species behave in the same way; as an instance, the only representative of *O. gigas* was isolated and made to fertilise itself. From it were obtained 450 plants, all of which, with only one exception, were *O. gigas*, the one exception not being a return to *Lamarckiana* but belonging to a new variety. The plant is a strong one and retains its properties in subsequent generations so far as investigated.

The *O. albida*, on the other hand, which appeared frequently, is a weak plant, not very fertile, but perfectly constant so far as it went.

The last species in the above list, the *Œnothera scintillans*, differs from the others in this respect, that it is extremely unstable, *i.e.* possesses the property of mutation to a high degree, a large proportion of its descendants belonging to other species, specially *O. oblonga* and *Lamarckiana* itself.

Want of space prevents us from going into further details. Enough has been said to show that de Vries has evidently made a momentous discovery. So far as his observations go, new species appear *suddenly* by *mutation*, never as the outcome of a progressive *variation*. With legitimate pride the author declares that he has been able for the first time to watch the formation and development of new species. The facts are so striking and convincing that an outsider like the reviewer cannot but feel that a new period in the theories of the origin of species and of evolution has been inaugurated.

As we saw, some of the new species which made their appearance did not seem to be inferior in stability to the mother-species; on the other hand, one of the species, the *O. lata*, only appeared as female plants without pollen, and the *O. albida* did not show the same vitality as the others and was evidently doomed to disappear again. The observations, therefore, do not support the idea that in the formation of new species Nature is carrying out a definite plan; on the contrary, it all looks like accident. A new species may be one strong and fertile enough to remain, and possibly, under favourable conditions, replace the mother-species, but it may just as well be a sickly kind without any chance in the struggle for existence. For the struggle for life between individuals de Vries substitutes the struggle for continued existence between species, the new species always appearing suddenly.

De Vries' views are thus directly opposed to the common form of the theory of evolution; not that the importance of the single variations had escaped attention altogether, but they were always lost sight of, and prime importance is generally attached to the selection through the ordinary variations. De Vries' experiments support the results arrived at by Scott and other palæontologists that there is no evidence in the successive strata of the earth of a gradual development of one species into another and that everything points at small but sudden transitions.

It can hardly be believed that the species which de Vries happened to come across can be the only living one possessing the property of mutation, and men of science may therefore look forward to a new period of extensive research on the lines of de Vries' work. One feels that new life has been infused into the problem, and that tangible facts are now available and experiments which will replace a good deal of rather empty theorising and hollow controversy between rival speculations.

Turning to physical research we naturally think, first of all, of the discovery made by Prof. Zeeman some years ago when still assistant at Leyden in Prof. Onnes' laboratory. This discovery of the influence of a magnetic field on the period and character of light radiated by a source in the field came just at the right time to bring the theory of ions or electrons into prominence, a theory the necessity of which had already appeared in many ways, and which had been worked out for the first time by H. A. Lorentz. In fact, without any calculation it is easily seen what influence a magnetic field must have on the light-vibrations, if these consist in the vibrations of charged particles. We have only to resolve the vibration of the electron in the direction of the field and at right-angles to it, and, again, the latter component into two circular vibrations of opposite directions, to see at once that the magnetic force must increase the centripetal acceleration in the one and diminish it in the other circle without affecting the third vibration; thus the ordinary doublet in the direction of the field, and the triplet in a direction at right-angles to it, both with their proper states of polarisation, may be directly inferred from the theory in its simplest form. The direction of the circular polarisation of the doublet shows the preponderance of the negative over the positive electrons in producing the phenomenon, and from the magnitude of the change in wave-length, *i.e.* the width of the doublet, the ratio of the charge of the electrons to their mass can be inferred.

It need not be here explained how these conclusions were confirmed by, and confirmed results obtained in the study of the conduction of electricity in gases, by J. J. Thomson and his pupils and others. Zeeman's phenomenon soon became public property, and has since been developed by many others as well as by Zeeman himself.

H. A. Lorentz, whose name is connected with Zeeman's discovery and its immediate explanation, published the first complete account of his electron-theory in 1892 in French, and a more complete version in 1895 in German ("Versuch einer Theorie der electrischen und optischen Erscheinungen in bewegten Körpern." Leyden: Brill). To this theory Lorentz was led by his discussion of aberration phenomena; there is, perhaps, no phenomenon which is so readily explained in elementary text-books but gives so much trouble when properly discussed as aberration.

Lorentz's researches led him to adopt Fresnel's theory, which assumes that the ether is at rest and that bodies move through it without disturbing it. This theory is in accordance with the negative results of Lodge's well-known attempts to put the ether in motion by spinning two heavy wheels close together in the same direction. Starting from this hypothesis and assuming that all electric phenomena—including light—in bodies are due to the presence, motion and vibration of electrons acting on each other through the ether, Lorentz developed a theory which leads to the proper Maxwell-equations for bodies at rest, and, moreover, explains the great majority of the experiments and phenomena relating to moving bodies—such as aberration, Doppler's principle and Fresnel's law for the velocity with which light is "dragged along" by a moving body through which it passes.

In order to account for the negative result of Michelson's aberration-experiment, Lorentz assumes, as was done independently by Fitzgerald, that a body moving through the ether diminishes in dimension in the direction in which it moves.

Particular interest attaches to a further development of the theory in the direction of an explanation of gravitation on electro-magnetic principles. In a paper published in 1900 Lorentz shows, first of all, that gravitation cannot be explained by assuming that bodies are constantly emitting electro-magnetic radiations of very short wave-length and high penetrating power, and that gravitation is due to the action of the ether in this disturbed condition on the electrons contained in bodies. Lorentz therefore proposes a different theory which is, in a way, an adaptation of Mosotti's theory of gravitation. Assuming that all bodies contain an equal number of positive and negative ions, it is clear that an explanation of gravitation by the mutual action of these ions, this action being, of course, transmitted by the ether with the velocity of light, can only succeed if it is assumed that in some way the condition of the field produced by a positive ion differs from that which is due to a negative ion; the action of the fields of the two kinds of ions on other ions is then supposed to be different, but in such a way that the action of a + field on a + or − ion is the same as that of a − field on a − or + ion respectively. Hence it follows that there will be no *electrical* action between two bodies containing ions, *i.e.* no tendency to separate the positive and negative ions, but a resultant action which constitutes what is observed as gravitation.

Lorentz then goes on to show the effect of the motion of attracting bodies in modifying the ordinary law of gravitation, and here he arrives at a remarkable result. The deviations from Newton's law depend on the ratios of the velocities of the bodies to the velocity of light, but only on the second power of these small ratios. Hereby he removes the grave difficulty first pointed out by Laplace against the assumption of a propagation of gravitation with a finite velocity, unless this velocity was millions of times greater than the velocity of light. By the peculiar way in which the condition of the ether is disturbed by a moving ion the effect of the motion on the apparent attraction is of a higher order of smallness, and, in fact, so small that no arguments can be drawn from astronomical data in their present degree of accuracy against the assumption. The latter result is independent of the special form which Lorentz gives to this theory, but holds for any electro-dynamical theory of gravitation on similar lines. Thus it looks as if there were no objection to applying this important unification to our physical theories. How Lorentz's work, some of it well known to every student of physics, is appreciated outside the narrow limits of his own country was shown not so many years ago when he received a call to the University of Munich to be Boltzmann's successor, an offer which he did not accept; and again in the end of last year, when physicists of all countries united in honouring him on his semi-jubilee as a doctor of physics. The *livre jubilaire* presented to him on that occasion contains some sixty contributions, about twenty of which are due to Dutch physicists, several to Lorentz's own pupils.

Not in the work of his pupils only do we trace Lorentz's hand; much of the work done by the Dutch physico-chemical school has been to a certain extent dependent upon his collaboration. In the book just mentioned we find this authoritatively declared by Bakhuis Roozeboom, the creator, we may say, of a new branch of physical chemistry, viz. the application of the phase-doctrine to all kinds of equilibrium. As one of the latest applications of this theory, we mention the attempted, and already partly successful, disentanglement of the iron-steel problem by le Chatelier, Roberts-Austen, von Jüptner, and Roozeboom himself (*Zeitschrift für physik. Chemie*). This application is instructive in showing how purely theoretical investigations may suddenly begin to bear upon highly practical problems and be applied for industrial purposes.

Roozeboom's pioneer work was carried out when still in the laboratory of the Leyden University. He is now at Amsterdam as van 't Hoff's successor. In his laboratory we find, working on independent lines, one of van 't Hoff's pupils, Dr. E. Cohen. Of the many investigations carried out by Dr. Cohen none is of more general interest than that on the enantiotropy of tin, partly carried out in conjunction with Dr. van Eyk. Tin—the white metal as we use it—has been known frequently, under the influence of intense cold, to change its condition completely by turning into a grey modification of lower specific gravity. This fact was known to the ancients, and the literature on the subject which the authors took the trouble to bring together forms quite a bulky collection. Nobody had succeeded so far in clearing up the chaos which surrounded the phenomenon and its explanation; this has now been done in the papers referred to. It appears that the change from white into grey tin is a reversible phenomenon, the transition temperature being 20° C.; this point was determined both with the dilatometer and electrically by the modern method of transition-cells. The transformation of white into grey tin goes on with increasing velocity the lower the temperature down to −50° C., after which it decreases rapidly. The existence of a maximum in the rate of transformation is in accordance with what occurs in the transformation of solids and liquids, *e.g.* the solidification of an under-cooled liquid (Tammann). The velocity is increased (1) by the addition of a little grey tin at the beginning; (2) by the addition of pink-salt; (3) by exposing the tin to the low temperature for a long period, or by alternately cooling and warming it. Above 20° the grey tin is transformed into the white modification with very rapidly increasing speed the higher the temperature. Measurements have been made up to 40°.

From the above experiments it appears that the whole of our tin-world, except on a few exceptionally warm days, is in an unstable condition. Dr. Cohen is now trying to establish the existence of similar transition-points for other metals.

Van Bemmelen's recent work on absorption and the properties of jellies is looked upon both by chemists and by physiologists as fundamental. In his researches on jellies he has struck out a new line in making accurate determinations of the relation between the vapour pressure of the jelly and its composition. One of the several new points discovered in that manner is that jellies, when taken through cyclic transformation, show hysteresis-phenomena, a circumstance which would not occur if the equilibrium between the jelly substance and the water was of a purely thermodynamical character, in which case the phase-rule with its consequences would hold. The equilibrium in the jelly depends upon its history, which is in accordance with the hypothesis that capillary forces are at work. Van Bemmelen looks upon a jelly as a system of two phases—a solid mixture of the colloid and water, and, embedded in the interstices of this mixture, water. In some jellies this solid part shows remarkable sudden transformation into a modification of different composition, but there is no indication of the existence of hydrates. It will interest the reader to hear that Prof. Bemmelen, having recently reached the age of seventy, has become a "professor emeritus" of the Leyden University. In the light of his recent experimental work there is some humour in the Dutch law considering a man of seventy unfit for a professorship. Van Bemmelen is succeeded by Schreinemakers, who may be described as Roozeboom's *alter-ego* (I am speaking from a scientific point of view).

Each country has its own bread, its own type of boots, its own characteristic music—can the same be said with regard to contemporary science? Looking broadly at the nature of the scientific work which is undertaken in different countries, and the manner in which the work is carried out and put before the public, we observe differences which are the natural manifestations of national characteristics. At the same time, these differences are chiefly external, superficial. No science, not even any special branch of a science, is now the property of any one nation. What appears to direct the exertions of the men of science of a country along particular lines more than national character is the influence of the few eminent men which the country is fortunate enough to possess. This influence in a small country like Holland is obvious even to the casual observer.

The origin of the young Dutch school of chemists is no doubt to be traced to van 't Hoff. In the same way we might speak of a Dutch school of which van der Waals is the origin. Those who want to acquaint themselves with the work done recently in this branch of physics are referred to the new edition of van der Waals' book on the continuity of the liquid and gaseous conditions. (German. Leipzig: J. A. Barth, 1900.) It is unnecessary to say anything of the first volume, which is a reprint of the former edition, and a translation of which has been available for several years. The second volume which has been added to the book contains van der Waals' theories of mixtures of two substances in the liquid and gaseous conditions. First of all we find a reprint of van der Waals's paper of 1890 in the *Archives Néerland-*

aires and the *Zeitschrift für physikalische Chemie*, and, secondly, later developments and additions and the application to recent experimental work, most of which was carried out by Prof. Kamerlingh Onnes and his pupils at Leyden. Van der Waals pays an eloquent tribute to Prof. Onnes' merits in this direction in the dedication of this second volume. It appears that but for him the original theory might never have been published and would certainly not have borne any fruit.

The importance of a theory of mixtures, as of other theories, lies in this, that it may show the connection between a number of phenomena which otherwise have to be treated separately, and may, directly or indirectly, bring to light new ones. That a theory was urgently wanted in the phenomena of mixtures even of two substances need not be set forth. In a theory of mixtures we may distinguish different parts, more or less independent of each other, which together form the whole. It consists firstly of an application of thermodynamics to find out the rules for the coexistence of phases—the gas and the one or two liquids. To do this it is only necessary to assume the experimental fact that the properties of mixtures form a continuous series between those of the components and, therefore, that a mixture has an equation of condition of the same general features as that of a single substance. Van der Waals is not the only man of science who has been working on these lines, although doubtlessly the first who conceived the notion of such a theory. Not only had special problems relating to mixtures been successfully treated by Konowaloff and others, but Duhem, applying his method of the thermodynamic potential, had been working in the same direction. In the reviewer's opinion, however, it cannot well be denied that the method used by van der Waals in attacking the problem by means of the "free energy" ψ, and its graphical representation, is by far the most effective and the safest guide amidst the intricacies of the problem.

Leaving alone questions of priority, we may say that the theory as sketched has led, more or less directly, to the complete disentanglement of the critical phenomena of mixtures, to the tracing of the proper features of the various diagrams between the pressure, volume, temperature and composition, and to the discovery of various other new facts, such as the existence of maxima and minima in the critical temperature and their connection with minima and maxima in the vapour pressure, and the influence of pressure on the coexistence of two liquids. All these and many other points are fully set forth by van der Waals in this second volume.

Van der Waals has not, however, contented himself with that; from molecular considerations he was able to deduce an equation of condition for mixtures of a definite form, depending, as does his well-known formula for single substances, on attraction-constants a and volume-constants b. It is somewhat to be regretted that in the original paper no attempt was made to guide the reader in ascertaining in how far special results arrived at were dependent upon this special equation or not; everybody will feel the importance of the distinction, and certain controversies which have arisen in connection with the theory would have been prevented by a clearer distinction on this head.

The importance of this point has increased lately in connection with the modern conception of normal (non-associating) and abnormal (associating) substances. Van der Waals' equation can be used for normal substances as an approximate guide, although even for these the approximation is veiy rough and hardly amounts to more than a certain resemblance, at least at small and medium volumes. For abnormal liquids the equation cannot even profess to do that, and van der Waals' results, in so far as they depend upon this equation, are not applicable to these substances at all. Lehfeldt has noticed that, so far as we know, normal liquids mix in all proportions and that partial miscibility occurs when at least one of the components is abnormal. Van der Waals' theory does not confirm this, inasmuch as such values may be assigned to the constants in his equation as will lead to partial miscibility. At the same time, as no normal liquids of partial miscibility have been discovered so far, this subject is outside the scope of van der Waals' equation.

The reader must not get the impression that results deduced for normal liquids by means of van der Waals' equation are of small value owing to the inaccuracy of the equation. An instance will illustrate this. Van der Waals discusses the question, also treated by Ostwald and others, what function of the composition of a mixture its vapour-pressure is. He arrives at certain conclusions, one of which is that there cannot be more than one maximum or minimum, at least that the combination of a maximum and a minimum is very unlikely. Guided by this result, Hartman (Leyden) has discovered that there is an obvious error in Konowaloff's result for propionic acid and water, the curve for this combination being in contradiction to Konowaloff's own measurements, and Kohnstamm, working in van der Waals' laboratory, similarly discovered an error in Linebarger's result for benzene and carbon tetrachloride, a result which, if it had been confirmed, would have been even more striking, as both these substances are normal. On the other hand, Caubet and Duhem maintain to have realised the double phenomenon in question with methyl chloride and sulphur dioxide; if the latter result were confirmed it would certainly show in a striking way with what extreme caution conclusions drawn from the approximate theory have to be accepted.

Owing to the recent establishment of a "van der Waals fund," the famous author is now in a position to conduct experimental researches in his own laboratory. Several valuable memoirs have already appeared under this trust.

A very interesting departure has been lately made by Kamerlingh Onnes and his pupils to construct plaster models of the ψ surface entirely based on experimental data. Models of that kind will no doubt become a powerful assistance in the understanding of the intricate phenomena displayed by mixtures.

Turning our attention towards the work which is being done in the Leyden laboratory, we notice researches which are being carried on relating to Hall's phenomenon, the magnetic rotation of the plane of polarisation and many others. A special feature of the work is the constant use of low temperatures down to the boiling point of air. We feel at a loss what particular part of the work to review specially; in the small space available no justice could be done to any one without being unjust to others, and we abstain from reviewing anything in particular, considering that the "Communications from the Physical Laboratory at Leiden" are widely distributed and will, no doubt, be sent to anybody interested who takes the trouble to apply for them.

Much else might have been mentioned in this review, but we have tried to select that which would find the largest number of interested readers. J. P. K.

MAXIME CORNU.

THE hand of death has been heavy on the French botanical world. In recent years it has fallen successively on Duchartre, Baillon, Naudin, de Vilmorin and Franchet: all men in the foremost rank, whom their fellow-workers in England counted as sympathetic friends. And now the untimely and unexpected death of Maxime Cornu has come upon many of us—and not least at Kew—as a personal grief. I saw him last autumn in Paris full of the business of congresses into which he was throwing himself with irrepressible vivacity and energy. He had often complained of ill health. But nothing in his appearance had ever suggested to me ground for serious anxiety. I had hoped to have induced him to pay us a visit this year. I could not go to his funeral; nothing remains but the sad satisfaction of writing these lines to his memory.

Cornu was born July 16, 1843, at Orléans. The ability which he displayed in his schooldays seemed at first likely to be absorbed by studies on the literary side. But under the influence of his father and of his distinguished brother, Alfred Cornu, he devoted himself to mathematics, and with considerable success. He published in the *Nouvelles Annales de Mathématiques* papers on geometrical subjects. In my judgment there could be no better preparation for a scientific career. Mathematics, as they are taught in France, habituate the mind to the grasp of general ideas and accustom it to rise from isolated facts to large generalisations. The descriptive side of science, it cannot be doubted, has a cramping influence, and it is the fate of too many of those who devote themselves to it to be unable "to see the wood for the trees." Cornu's mathematical studies, at any rate, decided him for a scientific career, and at the "École normale supérieure" he eventually fixed on botany. He was for a time assistant to Duchartre, professor at the Sorbonne, a man remarkable in many ways, but possessing in a more than ordinary degree the power of presenting with French lucidity the results of current research, not forgetting those of English workers. While with Duchartre, Cornu produced in 1873, as his doctoral thesis, his well-known memoir on the Saprolegniaceæ, to which the Academie des Sciences awarded the Desmazières prize. From the Sorbonne he moved to the Muséum as aide-naturaliste to Brongniart, whose daughter he afterwards married. Brongniart brought down to our own day the best traditions of that illustrious school of French botanists whose philosophic insight into the principles of plant morphology and taxonomy has probably never been rivalled, and certainly not surpassed.

Under Brongniart, Cornu devoted himself to mycology. He published in a comparatively brief period a profusion of papers, in which one is at a loss whether to admire most the untiring industry, the sagacity, or the wide range of his work. Everything pointed to his taking a foremost place in this branch of botany.

But no one can be a mycologist without being drawn into the study of plant diseases, in which fungi play so large a part. Vegetable pathology early attracted Cornu, and he did much excellent work in it. We owe to him the principle, now so familiar as to seem almost obvious, of preventive treatment by the careful destruction by burning of the *débris* of plants which may harbour resting-spores.

In 1868 a mysterious disease made its appearance amongst the vines in the South of France. Planchon, the professor of botany at Montpellier (who owed his early training to Kew), discovered the cause in an insect—*Phylloxera vastatrix*—introduced from the New World. The injury which this ultimately inflicted on the principal cultural industry of France has been compared, and probably with justice, to that of the most devastating of wars. That France has risen triumphant above this, as above so many other disasters, is but one example of the indomitable courage of its people. Cornu, from his official position and special qualifications, was necessarily at once absorbed in the task—hopeless as it seemed at first—of combating the scourge. For at least ten years, from 1872 onwards, he was occupied in little else. It is needless to enumerate the prominent position in various inquiries which he filled; the most important was that of "secrétaire de la commission académique du Phylloxera." His memoir on the whole subject published by the Academy has always seemed to me, for completeness and finish, a model of what such a research ought to be.

Cornu became the acknowledged authority on the subject of the Phylloxera. It had not been foreseen at first that the scourge, when once emancipated from its American home, might, and probably would, invade every wine-growing country. There were those who thought it impossible that it could cross the equator. The expectation was falsified and, in spite of all precautions, it made its appearance at the Cape. I advised the Cape Government to have recourse to Cornu, and his services were as generously given as, I know, they were warmly acknowledged.

In 1884 Cornu succeeded Decaisne as Professor of Culture at the Muséum—a position, if not so extensive in scope as that of the Director of Kew, scarcely less onerous. I had made Cornu's acquaintance some years before, and the circumstance of our similar official positions speedily brought us into closer intimacy. The position of an administrator under Government does not suit every temperament. The enthusiast must expect his ardour to be quenched with a good deal of official cold water. To Cornu, who had something of the engaging qualities of the *méridional*, this was hard to bear. My sympathy with him in his troubles, which were often not small, was certainly sincere, but I am afraid often seemed to him phlegmatic. In any case, the worries of administration pressed hardly on him and, notwithstanding the counsels of common friends, diverted him from the scientific work which we all expected of him, and which his really brilliant powers entitled us to expect.

At the moment that Cornu entered on his new duties, France had turned its attention anew to the field in which, in the past, it had done so much—colonial enterprise. Cornu's ambition—and it was a legitimate one—was to utilise the somewhat dormant resources of the Jardin des Plantes in the work, much on the lines of Kew. For my part it was more than a pleasure to give him all the assistance in my power. Agriculture is the great civilising agency. To reduce nomadic and predatory tribes to cultural pursuits is perhaps one of the most effective of missionary enterprises. Cornu threw himself into the work with little short of passion. What he accomplished, both for the French colonies and for the enrichment of the gardens of his own country, with resources more limited than we have at our disposal in England, is to me surprising. But, unhappily, at the moment when he had attained some measure of success his forces failed him, and he was not allowed to see his work fully crowned with accomplishment.

Cornu was the most loyal of Frenchmen. Had he been less so, he would not have sacrificed to the interests of France the career he might have devoted to science. I cannot but fear that while he lived the sacrifice he made was not fully appreciated. Many of us have wondered that a man who had done so much had never been admitted to the Institute. But that recognition could not have been long delayed, and this adds another regret to his untimely death.

W. T. THISELTON-DYER.

NOTES.

M. MAUPAS, of Algiers, has been elected a correspondant of the Section of Anatomy and Zoology of the Paris Academy of Sciences, in succession to the late M. Marion.

THE Harben medal of the Royal Institute of Public Health will be presented to Prof. Koch at a dinner to be held on July 24. Tickets may be obtained from the honorary secretary, Dr. W. A. Bond.

THE ethnographical collection of shamanistic implements, bead-work, musical instruments, &c., presented by Miss Owen to the Folklore Society, is on exhibition for a few days at the rooms of the Anthropological Society, 3 Hanover Square, W.

THE newly constituted "African Society," founded in memory of the late Miss Mary Kingsley, will hold its inaugural meeting at the United Service Institution, Whitehall, this afternoon, under the presidency of the Marquess of Ripon. This Society has been started with the object of studying the languages, laws and customs of the continent of Africa.

THE annual summer meeting of the Society of Public Analysts will be held at Cambridge on Friday, July 19.

PROF. RUDOLF VIRCHOW has been elected a knight, with the right to vote, of the Order Pour le Mérite for Sciences and Art.

AN official announcement has now been made in regard to the Rockefeller Institute for Medical Research, toward the establishment of which Mr. John D. Rockefeller has recently given 200,000 dollars. We learn from *Science* that the directors are Dr. William H. Welch, Baltimore, president; Dr. T. Mitchell Prudden, New York, vice-president; Dr. L. Emmett Holt, New York, secretary; Dr. C. A. Herter, New York, treasurer; Dr. Theobald Smith, Boston; Dr. Simon Flexner, Philadelphia; Dr. H. M. Biggs, New York. The purpose of the foundation, as the name implies, is to furnish facilities for original investigation, particularly in such problems in medicine and hygiene as have a practical bearing upon the prevention and treatment of disease. The sum of money mentioned above is not an endowment, but may be used for current expenses. The Institute will be situated in New York City. A building will not, however, be erected at present, but research will be conducted in existing laboratories under the auspices of the directors.

THE members of the Institution of Electrical Engineers who are participating in the visit to Germany have been heartily received at Berlin. On Monday they were entertained at dinner by the Berlin General Electric Company and by the firm of Siemens and Halske at the Berlin Fire Prevention Exhibition. Herr Geheimrath Rathenau, in welcoming the English guests, is reported by the *Times* to have said that electrical engineering, in which it would be admitted that Germany had made great progress, was "nothing else than the child of mechanical engineering, which Germans originally learned in England in the factories of London, Birmingham, Glasgow, &c." He thought they would admit that the English masters might well be proud of their German scholars.

IN the House of Commons on Monday Sir W. Hart Dyke asked the President of the Board of Agriculture if he intended to transfer the powers of his Board in respect of agricultural instruction to the Board of Education, he intended that the Board of Agriculture should undertake the organisation and coordination of such instruction throughout England and Wales. In reply, Mr. Hanbury said: "I am not prepared to transfer elsewhere any part of the existing duties of the Board of Agriculture, the functions of which, especially with regard to agricultural instruction, might, on the contrary, with advantage be enlarged. I am unable to state as yet in detail how this can be brought about, but I attach great importance to the necessity for extending the work already done by the Board in collating and publishing the results of experiments and the most recent discoveries bearing on agriculture, both in this country and abroad, and also to the advantage to be gained by friendly cooperation between the Board and county councils in devising the best methods of instruction and experiment."

THE movement to establish a Washington Memorial Institution for post-graduate study and research in Washington appears to have met with success. It originated in the Washington Academy of Sciences, and the organisation and scope have now been agreed upon. The primary aim is to facilitate the utilisation of the various scientific and other resources of the Government for purposes of research, thus co-operating with all universities, colleges and individuals in giving men and women the practical post-graduate training which cannot be obtained elsewhere in the United States and which is now available only to a limited degree in the city of Washington. An Act of Congress approving these principles was passed in March, and reads as follows:—"That facilities for study and research in the Government Departments, the Library of Congress, the National Museum, the Zoological Park, the Bureau of Ethnology, the Fish Commission, the Botanic Gardens, and similar institutions hereafter established shall be afforded to scientific investigators and to duly qualified individuals, students, and graduates of institutions of learning in the several States and Territories, as well as in the District of Columbia, under such rules and restrictions as the heads of the Departments and Bureaus may prescribe." The organisation is independent of Government control, and the management is vested in a board of fifteen trustees and an advisory committee composed chiefly of the heads of Government Departments. *Science* states that the new institution will attain substantially the objects desired by the advocates of a National University, without being subject to the objectionable features of a university sustained by the Government in competition with the existing universities.

THE Council of the Society of Arts have awarded the Society's silver medal to the following readers of papers during the session of 1900-1901:—Major Ronald Ross, F.R.S., for his paper on "Malaria and Mosquitoes;" Dr. W. Schlich, F.R.S., for "The Outlook for the World's Timber Supply;" Lieutenant A. T. Dawson, late R.N., for "Modern Artillery;" Mr. Fritz B. Behr, for "The Proposed High-Speed Electrical 'Monorail' between Liverpool and Manchester;" Mr. Percy R. Macquoid, for "Evolution of Form in English Silver Plate;" Prof. Raphael Meldola, F.R.S., for "The Synthesis of Indigo;" Sir Joshua Fitch, for "School Work in Relation to Business;" Mr. Marconi, for "Syntonic Wireless Telegraphy;" Mr. Henry John Tozer, for "The Growth and Trend of Indian Trade—a Forty Years' Survey;" Colonel Sir T. H. Holdich, K.C.I.E., for "The Greek Retreat from India;" Mr. J. D. Rees, for "Madras, the Southern Satrapy;" the Hon. Sir J. A. Cockburn, K.C.M.G., for "The Commonwealth of Australia;" Lieutenant Carlyon W. Bellairs, R.N., for "The Coal Problem: its Relations to the Empire;" Mr. William Burton, for "Recent Advances in Pottery Decoration;" and Mr. Hugh Stannus, for "Some Examples of Romanesque Architecture in North Italy."

AMATEUR photographers visiting London, and desiring to obtain pictures of interesting sights and objects, will find of service a leaflet prepared by Messrs. Sanders and Crowhurst and Mr. R. W. Paul. A list is given of suitable subjects, arranged in six groups, each group being sufficient for a day's work.

A MEETING of the Physical Society will be held on Friday, June 28, in the Wheatstone Laboratory, King's College, Strand, by invitation of Prof. Adams. Papers will be read on the effect of a high-frequency oscillatory field on electrical resistance, by Mr. S. A. F. White; and on the spectrum of cyanogen, by Mr. E. C. C. Baly and Dr. H. W. Syers.

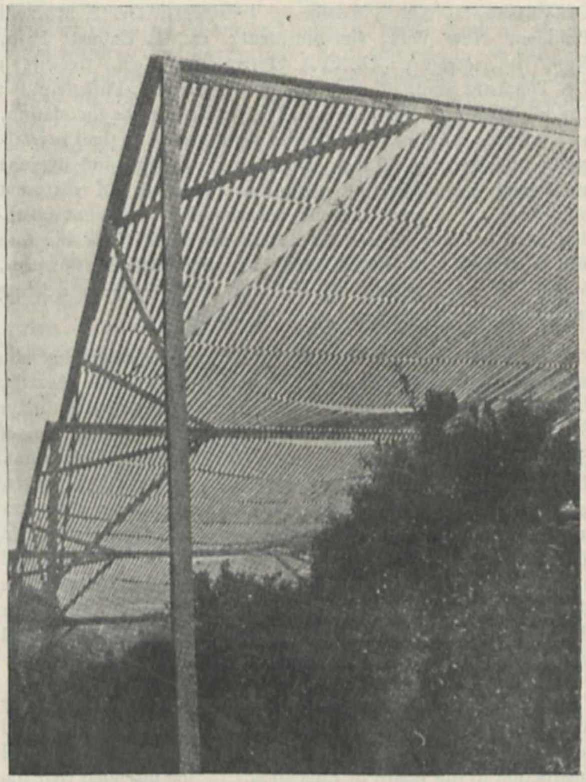
AN interesting incident is recorded in the *Engineer* (June 14). A petrol motor car returning from Biarritz to Paris came to a standstill near Etampes for want of petrol, and as another supply could not be obtained in the neighbourhood the driver resolved to try the only spirit obtainable—namely absinthe. He charged his car tanks accordingly, and afterwards declared that "the motor never ran better than with this improvised fuel."

PARTICULARS of the ethnographical survey undertaken by the Government of India in connection with the census, as suggested by the British Association, are given in the Allahabad *Pioneer Mail*. The following is a summary of the scheme prepared by the Government and sanctioned by the Secretary of State:—Local Governments will select from among their officers a superintendent of ethnography, who will undertake to carry on the inquiries proposed, in addition to his ordinary duties. The superintendent will correspond with the district officers with the object of ascertaining what persons in their districts are acquainted with the customs, traditions, &c., of particular tribes and castes. The information thus obtained will be collated by the superintendent, and will be supplemented by his own inquiries from such representative men as he can find, and by researches into the considerable mass of information in official reports, in the journals of learned societies and various books. The superintendent will work up all this material into a ystematic account of the tribes and castes of the province somewhat in the form adopted in "The Tribes and Castes of Bengal," and that followed by Mr. Crooke for the North-Western Provinces and Oudh. By working on these lines the Government of India believe it will be possible to get a fairly complete account of the ethnography of the larger provinces drawn up within four or five years. It is estimated that the survey will cost 10,000*l.*, excluding the cost of printing the results, which cannot be calculated at present. The Secretary of State has accorded his sanction to an expenditure not exceeding this amount. It is also proposed to collect physical measurements of selected castes and tribes. In Madras the work will be done by Mr. Thurston, superintendent, Central Museum, whose ethnographic researches in the south of India are well known, and who, it is understood, is likely to be selected by the Provincial Government as superintendent of ethnography for the Madras Presidency. The general direction of the scheme will be entrusted to Mr. Risley, whose official title will be for this purpose Director of Ethnography for India. The Governor-General in Council trusts that on this, as on former occasions, ethnologists and scientific societies in England and America will assist the Director with their advice, will refer to him points which they may wish to be made the subject of inquiry in India, and will, if possible, supply him with copies of publications bearing on the researches now about to be undertaken.

AMONG the many useful publications issued annually by the Royal Observatory of Belgium we draw special attention to "Éphémérides météorologiques et naturelles." The work is an excerpt from the "Annuaire météorologique" for 1901, and contains the monthly and annual values of the principal meteorological elements and phenological observations for Brussels (or Uccle) for each year from 1833 to 1900. Similar information relating to the wind has been published in a separate work. We extract the following interesting items from this long and valuable series of observations. The absolute maximum shade temperature was 95°·4 F. and the minimum 4°·4. The average annual rainfall amounts to 28·56 inches and the mean number of rainy days is 190. The relative humidity at noon is fairly uniform, varying in the yearly average from a minimum of 67·6 to a maximum of 79·9 per cent.

IN the *Bulletin* of the Cracow Academy M. S. Zaremba discusses the proof of the existence, for any given connected region bounded by a surface S, of a series of functions analogous to spherical functions and satisfying the well-known physical equation $(\nabla^2 + k^2)V = 0$. The fact that such functions exist was discovered by Poincaré, and demonstrated by Le Roy for surfaces satisfying certain conditions. Stekloff has studied the same problem from a different point of view, but the methods of Le Roy and Stekloff depend on certain transformations of the surface for which the existence of so-called fundamental functions has to be proved. M. Zaremba now claims, without employing any transformation, to have proved the existence of fundamental functions for any surface satisfying certain stated conditions, such as, for example, that the tangent plane at every point is unique. The series of functions has not been proved to be infinite in number, but this gap in the proof the author considers can be easily filled.

SYSTEMATIC efforts are made in California to reduce injury to fruits by frost. Mr. A. G. McAdie describes some of the means used in the U.S. *Monthly Weather Review* for February, and the accompanying illustration is one of several which illustrate his paper. This represents an elaborate structure of lath-screens in use upon one fruit ranch. The lath covering may be considered as forming a well-ventilated hot-house, and there is



Screen for protecting fruit from frost.

no question as to its protective value, but the expense of erecting it will prevent its wide adoption. An investigation of the conditions producing frost has shown that frost is primarily a problem in air drainage. Mr. McAdie states the principle that "wherever the air was stagnant the injury from frost was most marked; and conversely, wherever the air was in motion, there was little damage from frost." In California, much of the damage appears to be done by the sudden warming of the chilled fruit at sunrise. If a screen is interposed between the fruit and the sun, so that the warming is gradual, the fruit is saved from injury.

"SUNNY DAYS AT HASTINGS AND ST. LEONARDS" is the title of a well-illustrated and well-printed little handbook for south-east Sussex, by Messrs. W. H. Sanders and P. Row. There is a "six-inch" map of Hastings and St. Leonards, and another map, on the scale of an inch to four miles, of the country as far as Seaford, Tunbridge Wells and Ashford—all for the price of

6*d*., being vol. xvi. of the handbooks published under the auspices of the "Homeland Association for the Encouragement of Touring in Great Britain and Ireland." Apart from the descriptions of places of historic interest, including many famous old castles, it is interesting to find chapters on the geology of the district and on the prehistoric people of Hastings, by Mr. W. J. Lewis Abbott. The great physical changes recorded in the rocks are briefly pictured, though with few local descriptions, and then Mr. Abbott (whose enthusiastic labours in this field are well known) tells of the works of man in Plateaulithic, Palæolithic and later ages, concerning which abundant material has been obtained in Sussex and other parts of the south-east of England. A good account is also given of the various objects of interest in the Hastings and St. Leonards Museum.

FROM the Report of the Australian Museum for 1899 we learn that Mr. A. J. North's "Catalogue of the Nests and Eggs of Birds found breeding in Australia" is making satisfactory progress. The work, which is to include thirty plates of eggs and forty of nests, will be expensive, so that its cost is to be spread over several years. Apart from a complaint as to lack of funds, the general progress of the Museum seems to be satisfactory.

TWO interesting papers on wild life in Australia appear in the May number of the *Victorian Naturalist*, the one, by Mr. D. le Souef, being entitled "Among the Waterfowl in Riverina," and the other, by Mr. C. French, "A Naturalist on the Mallee." In the latter reference is made to the appearance of a swarm of caterpillars of the "army worm," which caused incalculable damage to the "wallaby grass." The caterpillars were, however, attacked in turn by a fungus (*Entromophthora australis*), which probably made a clean sweep of the entire horde.

THE latest issue of the *Zeitschrift für wissenschaftliche Zoologie*, which completes vol. lxix., is mainly devoted to morphological subjects, although it includes a description of a new genus (Ludwigia) of holothurian from New Zealand, represented by a species described in 1897 as *Colochirus ocnoides*. The morphological subjects comprise the development of the rook, the nature of the reproductive organs of the Ctenophora, the development of the vertebral column of the rat, the structure of the gills of fishes, and the difference between the female reproductive organs in the gnats and mosquitoes of the genera Culex and Anopheles.

TO the June number of the *Zoologist* Mr. W. W. Fowler communicates an interesting article on the winter singing of the thrush. Owing to the mildness of last November thrushes "were unusually numerous, and almost every individual seemed to be uttering some kind of song, and continuing it more or less from early morning, when the voicefulness was at its highest point, till sunset, and even later." The author set himself the task of determining whether this unusual outburst of song was due merely to the birds being in good condition, or whether it had any connection with the ensuing pairing-season. Despite a complete cessation between January 3 and 21, he inclines to think "that the great outbreak of song in the autumn was, in the case of mature birds at least, a forecast of the coming breeding-season."

THE most striking feature in the Report of the Field Columbian Museum at Chicago for the year 1899-1900 is formed by the full-page illustrations of groups of mammals mounted amid their natural surroundings. By far the best of these represents a party of five Somali hartebeests in the Haud desert, the attitudes of the animals being absolutely life-like. There is nothing to approach this grouping in our own national museum. The lectures delivered from time to time in the museum appear to attract good audiences. Two courses, one of eight and the other of nine lectures, were delivered during the period in question. They comprised anthropological, zoological and economic subjects. The total expenditure of the museum during the year was a little more than 24,000*l*.

WE have received a pamphlet indicating the contents of a bibliography and subject-index of the Schizomycetes (Bacteria) now appearing in the "Scientific Roll." It is stated to show the scope and extent of the work in January 1901, but is subject to alteration. The method of cataloguing seems to be to divide the subject into a number of groups—general, diseases, micro-organisms, &c.—each of which is again subdivided, and the subdivisions have appended to them the years in which papers on their subject-matter have appeared. In the second half of the work the matter is divided into years, and under each year an alphabetical list of authors is given, with the titles of their papers. The method of arrangement would have been rendered far clearer had a few specimen pages been included. The few references we have checked we have found to be accurately given. Judging from the list of contents there are overlappings and omissions. For example, "Bacillus of mouse typhoid" and "Bacillus typhi murium," "Bacillus of Plague" and "Bacillus pestis" are given as separate headings with different references, while "Micrococcus Melitensis" and "Bacillus pseudotuberculosis" seem to be omitted. The work may be, and might be made, a very valuable one, but details are wanting to enable a correct estimate as to its value being formed. For example, there is no indication whatever as to the journals, &c., that are to be indexed; a list of these should be given.

MR. BERNARD QUARITCH has issued a catalogue of the valuable entomological library collected by the late Mr. J. H. Leech, together with other important works on natural history and botany offered for sale at his establishment in Piccadilly.

MESSRS. DULAU AND CO. announce for publication in July a "Flora of Guernsey and the Lesser Channel Islands," by Mr. Ernest D. Marquand. The work will comprise classified lists, with full details of local distribution, of the flowering plants, ferns, fern-allies, characeæ, mosses, hepaticæ, fungi, lichens, sea-weeds, freshwater algæ, and diatomaceæ which have been found in Guernsey, Alderney, Sark, Herm, Jethou, Lithou, Crevichon and Burhou. Each island is treated as a separate and independent botanical area, possessing its own peculiar features. It is stated that upwards of 2500 different species are recorded for Guernsey alone.

THE syndics of the Cambridge University Press have undertaken the publication of the first part of the "Index Animalium," to the preparation of which Mr. C. Davies Sherborn has devoted so many years. The object of the index is to provide zoologists with a complete list of all generic and specific names given by authors to animals both recent and fossil since January 1, 1758, the date of the tenth edition of Linnæus' "Systema Naturæ." With each name will be given an exact date and a reference intelligible to the layman as well as to the specialist. The British Association appointed a special committee to watch over the inception and progress of the work, the preparation of which was undertaken in 1890. Financial support has been given by the British Association, the Royal Society and the Zoological Society, while the authorities of the British Museum have afforded continual assistance. The portion of the work already completed and in the press covers the period from 1758–1800 and consists of 61,600 entries.

WE have received from Messrs. Müller, Orme and Co. a specimen apparatus, designed by Mr. C. T. Tyrer, for use in making the Marsh-Berzelius test for arsenic. Commonly the flask in which the hydrogen or the arseniuretted hydrogen is generated is closed either with an ordinary cork or with an india-rubber stopper, and, with the object of arresting seleniuretted and sulphuretted hydrogen, the gas, as it passes from the flask to the mirror-tube, is brought in contact with lead acetate solution, sometimes bubbled through the liquid and sometimes passed through cotton-wool or over a roll of filter-paper saturated with the solution. Where cork has been in contact with arseniuretted hydrogen there is danger of sufficient of the arsenic compound being retained by this porous substance to render its continued use a possible source of error; with rubber there is always the chance that arsenic or antimony may be present as one of the constituents of the material, and as regards the use of lead acetate it has been urged that to bubble the gas through a small quantity of the solution is safer than to pass it through or over cotton-wool or filter-paper. The apparatus sent us has been designed to avoid the use of a cork or rubber stopper, and to include a convenient means of passing the gas through a minimum quantity of lead acetate solution. To a wide-necked flask of 200 c.c. capacity is fitted a hollow glass stopper, perforated by the gas-exit tube, which supports a bulb containing a small quantity of 10 per cent. acetate of lead solution. The stopper is ground to fit tightly into the neck of the flask, and as the gas passes up the exit-tube it bubbles through the lead acetate solution in the bulb and so on to a calcium chloride drying-tube, to which is attached the mirror-tube in which the arseniuretted hydrogen is decomposed. The apparatus is neat and effective.

THE additions to the Zoological Society's Gardens during the past week include three Derbian Wallabys (*Macropus derbianus*, ♂ ♀ and juv.) from Australia, presented by Captain Ben Jones; a Ring-tailed Coati (*Nasua rufa*) from South America, presented by Mr. Thomas Mackenzie; an Egyptian Jerboa (*Dipus aegyptius*) from North Africa, presented by Mr. J. Manuel; an Active Amazon (*Chrysotis agilis*) from Jamaica, presented by Mrs. V. A. Taylor; a Darwin's Rhea (*Rhea darwini*) from Patagonia, presented by Mr. H. F. Fox; a Large-billed Weaver-Bird (*Ploceus megarhynchus*, ♂) from Naini Tal, deposited; a Baya Weaver-Bird (*Ploceus baya*, ♂), two Black-throated Weaver-Birds (*Ploceus atrigularis*), a Black-headed Finch (*Munia malacca*), a Chestnut-bellied Finch (*Munia rubro-nigra*), two Hybrid Finches (between *Munia malacca* and *M. rubro-nigra*) from India, presented by Mr. Frank Finn; two Bennett's Wallabys (*Macropus bennetti*) from Tasmania, a Black Wallaby (*Macropus ualabatus*) from New South Wales, a Ring-necked Parrakeet (*Palaeornis torquata*) from India, an August Amazon (*Chrysotis augusta*) from Dominica, fourteen Algerian Skinks (*Eumeces algeriensis*) from North-west Africa, a Derbian Sternothere (*Sternothaerus derbianus*) from West Africa, three Simony's Lizards (*Lacerta simonyi*) from the Canaries, eight Three-streaked Skinks (*Mabuia trivittata*), two Streaked Skinks (*Mabuia vittata*), a Hissing Sand Snake (*Psammophis sibilans*) from Syria, four Grey Monitors (*Varanus griseus*), five Common Skinks (*Scincus officinalis*), four Ocellated Sand Skinks (*Chalcides ocellatus*), six Turkish Geckos (*Hemidactylus mabouia*) from Western Asia, deposited; an Axis Deer (*Cervus axis*, ♂) from India, purchased; six Silver Pheasants (*Euplocamus nycthemerus*), four Gold Pheasants (*Thaumalea picta*), six Common Pheasants (*Phasianus colchicus*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN JULY.

July 1. 9h. Jupiter in conjunction with moon. Jupiter 3° 42′ S.
1. 19h. Saturn in conjunction with moon. Saturn 3° 36′ S.
2. 9h. 29m. to 9h. 47m. Moon occults B.A.C. 6710 (mag. 6·0).
3. 11h. 2m. to 14h. 6m. Transit of Jupiter's Sat. III.
5. 9h. Saturn in opposition to the sun.
15. Venus. Illuminated portion of disc = 0·936, of Mars = 0·900.
17. 10h. 34m. Minimum of Algol (β Persei).
22. 10h. 59m. Moon in conjunction with α Virginis (Spica).
24. Saturn. Outer minor axis of outer ring = 18″·08.
28. 9h. 51m. to 11h. 6m. Moon occults 21 Sagittarii (mag. 4·9).
28. 11h. Jupiter in conjunction with moon. Jupiter 3° 37′ S.
29. 0h. Saturn in conjunction with moon. Saturn 3° 34′ S.
29. 8h. 33m. to 9h. 48m. Moon occults *d* Sagittarii (mag. 4·9).

BLACK SPOT ON JUPITER.—On June 2, Sig. J. Comas Sola, working at the observatory of Barcelona with a six-inch Grubb equatorial (power 200), noticed a strange marking on System II. of the planet's belts. From the time at which it passed the central meridian on that day its longitude would appear to be about $\lambda = 73°·1$; its latitude would be about 15°.

The tone of the spot is almost black, with a light garnet tinge, and might without close attention be mistaken for the shadow of a satellite. It is very sharp and circular, but on careful examination a very pale penumbra is seen before and behind the spot itself, the posterior penumbra being the more prominent of the two.

No signs of this spot were apparent on May 31.

TEN-YEAR GREENWICH STAR CATALOGUE FOR 1890.—The second ten-year star catalogue recently issued from the Royal Observatory forms Appendix II. to the *Greenwich Observations* for 1898, and contains the reduced places of 6892 stars for the epoch 1890·0, from observations made with the transit circle during the period 1887–1896.

The various corrections investigated are described at length, one interesting point brought out being that the observations from 1895–1899 show a diurnal change in the position of the nadir, the observations taken about noon and midnight giving positive corrections to the observations made near the time of sunset.

Comparisons are also given with the data of other standard catalogues, from some of which the proper motions of 174 stars are deduced.

NEW NEBULÆ.—In the *Comptes rendus* (vol. cxxxii. pp. 1465–1467) M. Bigourdan gives a descriptive table of twenty-one new nebulæ discovered with the north-west equatorial of the Paris Observatory, bringing up the number found in this way to 392.

PARALLAX OF μ CASSIOPEIÆ.—The eighteenth volume of "Contributions from the Observatory of Columbia University" contains an investigation of the parallax of μ Cassiopeia, made by Mr. G. N. Baur from the Rutherfurd photographic measures of twenty-eight plates of the region taken during 1870–1873.

The final value determined for the parallax is

$$\pi = 0''·238 \pm 0·014.$$

A table is also included showing the positions of fifty-six of the neighbouring stars used in the determination.

NEGATIVE AFTER-IMAGES AND COLOUR-VISION.

FOUR years ago I described an apparatus by which apparent transformations of colour could be produced (*Proc. Roy. Soc.*, vol. lxi. p. 268; NATURE, vol. lvi. p. 128). The essential part of it is a disc, partly black and partly white, having an open sector at the junction of the black and white portions, as shown in Fig. 1. If such a disc is caused to turn five or six times in a second while its surface is strongly illuminated, a coloured object placed behind it and viewed intermittently through the opening generally appears to assume an entirely different hue, more or less approximately complementary to the true colour of the object. A piece of red ribbon, for example, is seen as bluish-green and a green one as pink. The effect is due to the formation of negative after-images upon the white portion of the disc.

A number of observations made with this apparatus showed that the "pulsative after-images," as they may be called, differed in several important respects from the ordinary negative after-images seen upon a white ground after the gaze has been fixed for some time upon a coloured object. Among other things, they often appeared much more intense or saturated, which for obvious reasons was rather surprising. And again, it was found that the colours of the pulsative and of the ordinary after-images were sometimes very different. The pulsative after-images of red, of purple and of orange, for instance, were all of nearly the same bluish-green tint, and those of yellow and of blue were generally pink, showing considerable variations from the true complements. These and other anomalies led me to make some experiments with spectrum colours, which could be blended into uniform mixtures of known composition, instead

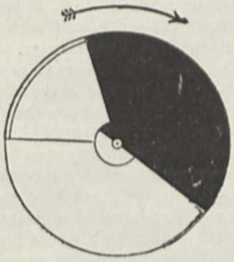


FIG. 1.

of with pigments, the apparatus employed for the purpose being a simple form of Sir Wm. Abney's well-known "colour-patch" apparatus. The experiments, of which a short account is here given, are fully described in a paper recently communicated to the Royal Society (*Proc. Roy. Soc.*, May 23).

A short pure spectrum, some three or four inches long, is projected, by means of a spectroscope collimator, a prism and an achromatic lens, upon an arrangement known as a "slit-screen." This consists of a wooden board having an oblong window over which slide three brass slit-frames carrying adjustable slits. The two outer slit-frames are attached to sliding shutters, which serve to cover such portions of the window right and left of the slit-frames as would otherwise be open to the light; the spaces between the middle slit-frame and the two outer ones are closed by opaque black ribbons, constituting miniature spring-roller blinds. Each slit-frame can be moved independently to any desired position and clamped by a set-screw. When it is necessary to use larger portions of the spectrum than can be transmitted by the slits, the slit-frames and their appurtenances are removed from the screen and the spectrum is dealt with by means of one or more thin metal plates, which are inserted into a second pair of guides fixed on the other side of the screen. Each of these guides has three parallel saw-cut grooves in it, so that plates sliding in different pairs of grooves may be made to overlap one another, and thus screens or openings of almost any desired width may be provided with very little trouble. The selected portions of the spectrum pass through the slits to a large lens, which projects upon a white screen the image of a circular aperture in a diaphragm placed just in front of the prism. This image, which is $1\frac{1}{2}$ or 2 cm. in diameter, constitutes the colour-patch; it is illuminated by a uniform mixture of the spectrum-rays transmitted by the slit-screen. When the wave-lengths of the light are to be determined a screen of ground glass is put in the place of the opaque white screen and the slit of a spectroscope is brought near the bright image on the glass. To produce a bright ground upon which to see the after-images a beam of white light, derived from the same electric arc as the spectrum, is directed upon the screen. The white light passes through the aperture of an iris-diaphragm, and a lens is placed to project an image of the aperture upon the screen. The "white-light disc" so formed is concentric with the colour-patch, and in most cases of slightly greater diameter.

In the path of the two beams of light illuminating the colour-patch and the white-light disc is placed a zinc disc having two apertures, one near the centre to admit the spectrum-rays, the other near the circumference to admit the white light. This is caused to turn about five times in a second, and the apertures are so arranged that the sequence of phenomena produced upon the screen may be as follows:—The colour-patch is projected for about 1/40 second, then it is extinguished and immediately succeeded by the white-light disc; this remains for 3/40 second, and is followed by an interval of darkness lasting 1/10 second, after which the colour-patch reappears and the cycle begins again. The appearance presented to the eye when the true colour of the patch is green is that of a purple disc surrounded by an annulus of flickering white. Other colours, of course, produce pulsative images of different hues. It is sometimes better to view the pulsative image directly by means of an eye-piece instead of receiving it upon a screen; two or three methods by which this can be effected are described in the paper.

Perhaps the most interesting of the various effects observed with this apparatus is one which appears to throw some light upon the origin of the pulsative image and to show why the true colour is so completely lost. It was noticed that when the white-light disc was made a little smaller than the colour-patch, the pulsative image, which was in this case of the same size as the white-light disc, was surrounded by a dark ring. This observation led me to make what is called in the paper the "black spot" experiment. A circular piece of tinfoil was gummed to a glass plate which was placed behind the iris-diaphragm, a sharply defined black spot being thus formed in the middle of the white-light disc, as indicated in Fig. 2, where the outer circle represents the white-light disc, the shaded circle the colour-patch, and the inner one the black spot upon the white-light disc. The diameter of the black spot was made, after several trials, 0·6 cm., or rather more than one-third of the diameter of the colour-patch. Suppose the colour-patch to be green. When the apparatus is worked, the patch becomes purple; the site of the black spot, being strongly illuminated five or six times in a second by green light, might be expected to appear green; but it remains perfectly black; no trace of a flicker of green light can be seen upon it. This induced blindness is most conspicuous when the light is green or yellow; it does not occur at all with extreme red or with violet light; nor does it generally occur if the luminosity of the colour-patch is reduced below a certain limit, that of the white-light disc remaining constant. A colour of feeble luminosity can be seen upon the black spot, while a brighter cannot, which is a paradox; and it was noticed that as soon as the spot became distinctly coloured, the pulsative image almost disappeared. Absence of colour from the black spot is essential for a good pulsative image.

It is clear that we have here an example of what I have called in other papers a border effect; in certain cases light has the power of exciting some action just outside the boundary of the image projected upon the retina. The black spot is, of course, merely a device for exhibiting in a convenient manner a border

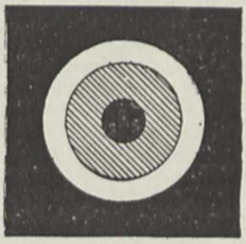


FIG. 2.

effect which extends for about half a degree beyond the white light impression. The experiment proves conclusively that, under the given conditions, white light has the power of restraining the visual sense-organs adjacent to those upon which the white light actually falls from responding to the green stimulus. This is of importance as indicating what occurs within the area illuminated by white light, for it would seem to follow *a fortiori* that the sense-organs which are directly acted upon by the white light must be similarly incapacitated from evoking any green sensation. In the formation of the pulsative image, then, it is not the fact, as generally believed, that the green sensation is produced for a moment and then swamped by a more powerful white one so completely as to escape notice; it actually never comes into existence at all. Nevertheless, the effects of fatigue by green are exhibited, and the physically white ground is seen as purple.

Only one possible explanation of the phenomenon has yet occurred to me. The facts can be accounted for in a perfectly simple manner if we suppose, as postulated by the theory of Hering, that there is an independent white sensation, and, further, that the latent period for a colour sensation is very much greater than that for white. For green, under the conditions of my experiments, the latent period would be at least 1/40 second, while for white it can hardly exceed 1/500 second, though the luminosity of the two may be as nearly as possible equal. The latent period for red is probably not very different from that for green under similar circumstances, while that for blue is considerably greater.

If in a darkened room a ray of green light is admitted to the eye for 1/40 second, one sees a flash of green; but, assuming that the suppositions which have been put forward are correct, the visible flash is not contemporaneous with the physical illumination. One does not begin to experience the green sensation until after the green ray which excited it has been shut off. What is actually perceived is, in fact, a positive after-image, the duration of which may be considerably longer than that of the stimulus. But if a sufficiently luminous white surface is presented to the eye immediately upon the expiration of the brief period of stimulation by green light, the after-image formed will not be positive, but negative, and the only colour perceived will be purple. The fatigue to which the negative image is due must have been set up during the latent period, when no image at all was actually perceived.

The formation of vivid pulsative images depends not only upon the latent period, but also upon persistence, luminosity, the duration of the primary impression and of the periods of light and darkness, and upon other circumstances. And the conditions which are best for some colours are not so for others. This fact obviously suggests that the pulsative image might afford a means of analysing compound colour-sensations, though so far it has been found available only to a limited extent. If the complete spectrum is projected upon the screen, it is seen at once that the blue-green pulsative image of the red, and the purple pulsative image of the green, are far more intense than the pulsative images of the yellow, the blue and the violet portions of the spectrum. Accordingly, if we make an orange colour-patch by combining red and yellow rays, it is not surprising to find that its pulsative image is blue-green, hardly differing at all from that of red, instead of sky-blue, which is the colour of the ordinary after-image of orange. Now the pulsative image of a patch illuminated by the simple orange rays of the spectrum is also found to be blue-green; hence the inference is clearly suggested that the spectral orange rays excite a red sensation. This particular fact will probably be regarded as one which needs no demonstration, but it is mentioned as an illustration of the proposed method of analysis. Several others in which the conclusions can be verified by trial might be given. Now it is noticed that under most ordinary conditions the purple pulsative image of green is more easily produced than that of any other colour. Under the same conditions we find that the pulsative images of yellow, of blue and of white are purple, and, assuming that the test referred to is a sound one, we conclude that yellow, blue and white all excite a green sensation. The proposed method of analysis may probably be carried much further than has yet been done.

This paper also contains an account of some new observations upon a class of phenomena to which I have drawn attention in a former communication (*Proc. Roy. Soc.*, vol. lx. p. 368; NATURE, vol. lv., p. 367). If the image of a white object is suddenly formed upon the retina after a period of darkness, the object generally appears to be surrounded for about one-tenth of a second by a narrow red border. It was noticed that when the bright object producing the image was looked at through variously coloured glasses the red border did not appear unless the glass used was capable of transmitting red light, and it was suggested that the phenomenon was due to sympathetic excitation of the "red nerve-fibres" lying immediately outside the portion of the retina directly affected by the radiation. The orange and yellow glasses employed for the observations referred to of course transmitted red light. Using the pulsative image apparatus with the eyepiece method, I now find that the simple red, orange and yellow rays of the spectrum, whether alone or in conjunction with any others, are competent to produce the red borders. The effect stops short at the beginning of the greenish-yellow. When blue and green rays are employed to illuminate the patch, either separately or in combination with each other, a blue-green border is produced. This is less intense than the red one before referred to, but if viewed in the manner described in the paper, the appearance of the green border due to pure spectral blue light of about $\lambda 4700$ is very striking. Violet produces no coloured border of the kind, and its admixture with other rays has no sensible effect upon the phenomenon. It can hardly be doubted that effects which occur, sympathetically as is suggested, just outside the boundary of the physical image, must also occur within the boundary; and if that is so, it follows that red, orange and yellow rays, nearly up to the beginning of the greenish-yellow, excite a red sensation, while green and blue excite a green sensation. There is at present no evidence of the same kind as to the existence of any other fundamental colour-sensation, though there must, of course, be at least one more.

The bearing of these border experiments upon theories of colour-vision is indicated in the paper. The following is among the most important points referred to. It is found that a comparatively small proportion of red mixed with other spectral rays results in the formation of a red border. According to the Young-Helmholtz theory, green spectral rays excite the fundamental red sensation to about the same extent as orange-red rays; yet no red border is formed by the green, though that formed by the orange-red is very strong. The natural deduction is that no red sensation is excited by green light.

As regards a different point which has been much debated, certain observations seem to be absolutely conclusive. According to Helmholtz the phenomena of simultaneous contrast are due entirely to mental judgment; according to Hering their origin is a physiological one. Experiments with one of the eyepiece methods, in which the apparent diameter of the pulsative image is about one-fourth of that of the white-light disc or field of view, seem to place the matter beyond dispute. If a purple pulsative image is produced from a strongly illuminated green colour-patch, the whole of the physically white field surrounding the patch appears to be purple. It cannot possibly be that the colour of the ground is a psychological effect resulting simply from contrast with green, for no green whatever is consciously perceived; the cause must necessarily be of a physiological nature. A similar effect is produced in an even more striking degree by blue and by violet colour-patches, the whole field appearing to be of the same hue as the pulsative images, namely orange and yellow. Phenomena of simultaneous contrast, as they are called, are therefore certainly not in all cases to be explained solely on psychological grounds.

The experiments which have been discussed establish nothing decisively in favour of either of the two principal theories of colour-vision. Some of the observations seem to support the Young-Helmholtz theory, others that of Hering; others, again, appear to indicate that neither theory in its present form is tenable. I venture to think that our knowledge of the subject might be materially increased by further experiments on the lines of those described.

SHELFORD BIDWELL.

THE SECOND INTERNATIONAL CONFERENCE FOR THE EXPLORATION OF THE SEA.

AFTER the International Conference which met at Stockholm in June 1899 for the consideration of a scheme for the systematic scientific study of fishery questions, it was proposed to meet again to complete the programmes at Christiania in the autumn of 1900. Various circumstances made it necessary to postpone the meeting, which eventually took place in the second week of May, when representatives of Germany, Belgium, Denmark, Finland, Great Britain, Norway, Holland, Russia and Sweden (the order is that adopted in the official *compte-rendu*—alphabetically in the French language), to the number of twenty-five, assembled in Christiania. The delegates included Dr. Herwig, president of the German Society for Promoting Sea-fisheries; Profs. Krümmel and Brandt of Kiel, and Profs. Heincke and Henking from Germany; Prof. Gilson of Louvain from Belgium; Captain Drechsel, Dr. Martin Knudsen and Dr. C. G. J. Petersen from Denmark; Dr. Nordqvist from Finland; Sir Colin Scott Moncrieff, Prof. D'Arcy Thompson, Dr. H. R. Mill and Mr. W. Garstang from Great Britain; Prof. Nansen and Dr. Hjort from Norway; Dr. P. P. C. Hoek from Holland; Dr. Knipovich from Russia; and Profs. Pettersson and Cleve, Dr. Trybom, Captain Maechel and Messrs. Wijkander and

Ekman from Sweden. Dr. H. H. Gran and Mr. K. V. Hammer acted as secretaries, and Profs. G. O. Sars and Mohn were invited to take part in the deliberations of the Conference.

The Norwegian Government received the Conference, the Prime Minister, Mr. Steen, acting as host, and very cordial messages were received from the King. The Municipality of Christiania also showed a lavish hospitality, and everything that could be done to promote the comfort of the delegates had been thought of and provided for. The meeting lasted from Monday, May 6, to Saturday, May 11, and the work—either in the full meetings, in committees, or, by no means least important, in personal conversation—was practically continuous from early morning till past midnight. The result was, on the whole, highly satisfactory; concessions had doubtless to be made all round, and some conclusions which might not be the best conceivable had to be accepted as the best obtainable; but the harmony of the international fellow-workers was unbroken, and during the whole meeting no question had ever to be put to the vote, agreement in every case being unanimous. The president of the Congress was Prof. Nansen, but the chief delegate of each of the chief countries represented presided each on one day.

The first work was the revision and completion of the Stockholm programme in its two divisions, which were known as the hydrographical and the biological. The former division, having been well elaborated at Stockholm, was easily disposed of, but the biological programme was entirely recast, several independent schemes of work which had been brought forward by the delegates having to be combined with the provisional programme. Next came the question of the organisation of the scheme of international research, which was only partially achieved. As it was necessary to refer several points to the various Governments concerned, it was decided that a committee of the vice-presidents should draft a series of recommendations to be sent in the same form to all the participating Governments, but not to be made public until a decision had been arrived at. Finally, a number of resolutions in the form of "pious opinions" were proposed and adopted.

The introductory clause of the official report, referring to the complete programme, runs: "Considering that a rational exploitation of the sea should rest as far as possible on scientific inquiry, and considering that international cooperation is the best way of arriving at satisfactory results in this direction, especially if in the execution of the investigations it be kept constantly in view that their primary object is to promote and improve the fisheries through international agreements, this International Conference resolves to recommend to the States concerned the following scheme of investigations which should be carried out for a period of at least five years."

A. *Hydrographical Work.*—The object of this work is defined as the distinction of the different layers of water according to their geographical distribution, depth, temperature, salinity, dissolved gases, plankton (as an index of movement of water) and currents. To effect this object it is recommended that simultaneous observations should be made in the North Sea, English Channel, Baltic and North Atlantic along certain definite lines four times in the year, the middle point of the series of observations being in the first half of February, May, August and November. Instruments and methods are prescribed, and it is provided that meteorological as well as oceanographical observations shall be made, and that facilities shall be offered to the various national meteorological offices to cooperate in the study of the upper atmosphere at sea by the use of kites. The observations made on each of the international trips are to be plotted on synoptic charts at the earliest possible date after the return of the vessels. Stress is laid on the provisional nature of any determinations of salinity or density made at sea, and on the importance of carrying out such observations with the highest precision in laboratories on shore. The unit of depth is to be the metre, although it is allowable to add the depths in fathoms. The sea-mile is to be the unit of horizontal distance. For temperature, thermometers graduated in either centigrade or Fahrenheit degrees may be used, but all readings are to be reduced to centigrade for publication. While the new tables of the physical constants of sea-water prepared by Dr. Martin Knudsen, of Copenhagen, are to be employed, and are sufficient for their purpose, it is pointed out that it is desirable to have the existing tables of the absorption of atmospheric gases in sea-water revised. The mapping of the deposits on the sea-bed of the area to be studied is another desideratum to which attention is called. It is also pointed out that it is desirable to encourage regular observations of surface temperature and the collection of samples of surface water on board the steamers of regular lines which cross the area under investigation, a branch of work which has yielded excellent results in the hands of the Danish Meteorological Institute and in those of Mr. H. N. Dickson.

B. *The Biological Programme.*—Here two classes of recommendations are to be distinguished, those referring to obligatory work which each of the nations concerned is held bound to carry out, and to optional work, which, while desirable in order to complete the scheme of investigation, is not of such urgent importance. The areas in which the various nations are to work are suggested both for the hydrographical and the biological researches. Briefly put, they provide that the North Sea south of 58° N. should be divided by the meridian of 2° E., to the west of which British vessels should do the work, to the east of which Belgium, Holland, Germany and Denmark should undertake the sections lying off their own coasts. From 58° to 62° N., Great Britain, Norway and Denmark would share the work in the North Sea and North Atlantic. From 62° northward would be the sphere of interest of Norway in the Atlantic and of Russia off the Murman coast. The Baltic and its approaches would be dealt with by the three Scandinavian nations, together with Germany, Russia and Finland. No objection would be made to any of the research vessels extending their operations beyond the area allotted to them provided that the work in that area is not neglected.

The biology of food fishes is to be investigated in a comprehensive manner. The preparation of charts is recommended, showing the distribution in all their stages of growth of plaice, sole, turbot, cod, haddock and herring in the North and Arctic Seas, and of flounder, cod, sprat and herring in the Baltic. The observations to yield data for these charts are to be carried out as often as possible and with uniform trawls and other appliances, while the measurement and all particulars of the fish caught are to be recorded in a systematic and uniform manner.

In this respect optional researches are suggested on the life-history of food fishes with regard to their development, migrations and feeding places, all in connection with hydrographical conditions. To help towards this end the liberation of marked fish over wide areas and in large numbers is recommended. It is also considered useful to inquire as to whether fish of different species after being caught by various methods are likely to live if immediately liberated.

The study of the quantitative distribution of pelagic eggs, larvæ and young fishes is to be carried out as part of the routine work at all stations where physical observations are made, the method recommended being by vertical hauls of Hensen's large egg-net. As an optional extension of this part of the work the study of the eggs and young of food fishes may be continued in the intervals between the quarterly cruises, and experiments should be made on the artificial fertilisation and hatching of ova.

The researches of individual specialists are to be promoted by the collection of material as to the local varieties of plaice, herring and mackerel in the entire area subject to international investigation, and such researches may also be extended to include other useful species. The areas where undersized or immature fish specially abound are to be very carefully inquired into, and the quantity of such fish landed at the various ports as the result of various methods of fishing are to be ascertained. The statistical methods may be extended by the occasional sending out of experts on board fishing vessels to examine the catch as it is brought on board.

The study of plankton and bottom fauna is to be carried out by qualitative samples being collected as one of the routine operations at the various stations for hydrographic observations on the quarterly cruises, not merely from the surface, but by vertical hauls. Where possible, similar collections at other times and at regular shore stations is recommended as an optional extension. Quantitative hauls with Hensen's plankton-net are also recommended, the material collected being offered for examination to specialists who may be willing to undertake the work of quantitative determination. Endeavours should be made with suitable apparatus to investigate the organisms which inhabit the lowest water layers immediately above the bottom. The macroscopic animal and plant life of the bottom should also be studied, with special reference to the nutrition of food fishes. Among the optional researches which are suggested with reference to the bottom fauna are observations on the bacteria of the bottom and of the water immediately above.

The last section of the biological programme deals with the importance of elaborating fishery statistics so as to yield data for constructing maps of the fishing grounds, and for determining the influence of physical conditions on fish.

With regard to the apparatus to be used in these observations, Prof. Nansen, Dr. Hjort and Mr. Garstang gave a demonstration on board the *Isbjorn* in Christiania fjord of the insulating water-bottle as used for exact measurements of temperature, and of various forms of closing tow-nets.

C. *Organisation of the International Council, Central Bureau and International Laboratory.*—The organisation which is to put the elaborate system of observations recommended by the Conference into operation and to record and work out the result is obviously the most important part of the whole scheme, as upon its successful working depends the whole of the success of the attempt at concerted action. The International Council is thus described :—

"The permanent International Council shall consist of commissioners elected by the Governments interested. Each Government should appoint two commissioners who may be represented at meetings by substitutes, and may be accompanied by experts who, however, shall not be competent to vote.

"The council elects its president and vice-president and appoints all officials of the Central Bureau. Should the general secretary represent hydrographic science, one of his principal assistants should be a biologist, and *vice versa*. The other assistant shall preferably be experienced in statistical work. . . .

"It will be for the Governments concerned to decide among themselves the amount of the contributions to the Central Organisation. The expenses of the Central Organisation are approximately estimated at 4800*l*. yearly. . . .

"The purpose of the Central Bureau will be :

"To give uniform directions for the hydrographic and biological researches in accordance with the resolutions drawn up in the programme of the present Conference, or in accordance with such modifications as may be introduced later with the consent of the States represented.

"To undertake such particular work as may be entrusted to it by the participating Governments.

"To publish periodical bulletins which shall contain the actual data obtained in the cruises of all the participating States at the earliest possible date, and also such other papers as may prove useful in coordinating the international work. . . .

"The site of the Central Bureau, to be decided by the Governments concerned, shall at the same time be the residence of the general secretary.

"The purpose of the International Laboratory shall be :—

"To control apparatus and to ensure uniformity of methods. The various apparatus and instruments now used for oceanic research should be examined in order to settle which are the most trustworthy. Experiments may also be made to improve the apparatus and instruments or to construct new and better ones.

"The water-samples sent by the workers of the participating States are to be analysed and examined at the Central Laboratory, from which also samples of standard water should be provided. . . .

"The International Laboratory is subordinate to the Central Council, to which its accounts shall be rendered. Its operations shall be reported to the Central Bureau.

"The site of the Central Laboratory shall be decided by the Governments concerned, and should be conveniently situated for oceanic researches."

The relations of the Central Bureau and the International Laboratory will probably be somewhat difficult to define, and the success of the two practically independent institutions will depend on the strength and tact of the International Council, the selection of the members of which will devolve upon the Governments associating themselves with the work.

Resolutions.—The general resolutions adopted by the Conference included an expression of the desirability of the provision of at least one steamer specially adapted for marine research by each of the participating States. This is so self-evident as hardly to require statement. Norway already possesses such a vessel in the *Michael Sars*, which has already done excellent work under Dr. Hjort; Russia has also equipped a vessel for fishery observations, and Germany has sanctioned a very carefully-planned ship, involving some very important innovations, which is now, we believe, almost ready to be launched. To carry out the British share of the work properly two vessels will be required, and for so promising a field of practical application of science it seems reasonable to hope that they will be provided.

The opinion is formally expressed that the Central Bureau should commence operations as soon as possible, and not later than the beginning of next year, while the first set of international cruises should take place not later than May 1902. To make this possible it is recommended that the International Council should meet in Copenhagen as soon as the participating Governments decide to accept the programme of the Conference.

A resolution expresses sympathy with the efforts of Governments which are endeavouring in the face of difficulties from foreign trawlers to preserve an area, such, *e.g.*, as the Moray firth, from fishing operations, for experimental purposes. Another thanks Dr. Knudsen for his recently published hydrographical tables, in which he gives a new determination of the physical constants of sea-water. The remaining resolutions suggest methods for graphically representing the dynamics of oceanic movements, approve of the inclusion of observations on freshwater lakes simultaneous with, and similar to, those on the sea, and point out the importance for deep-sea fisheries and for weather forecasts of bringing the Faeroes and Iceland into the telegraphic system of Europe.

It remains now for the Governments of the northern marine nations of Europe to give effect to this carefully planned scheme.

H. R. M.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The following is the text of the speech delivered by Prof. Love in presenting Dr. P. L. Sclater for the degree of D.Sc. *honoris causa*, on June 20 :—

Adest Philippus Lutley Sclater, Sodalis Societatis Regalis, Magister Artium in Academia nostra, Philosophiæ Doctor in Bonnensi, Collegii Corporis Christi Socius honoris causa creatus. Qui vir, ut primos eius annos et incunabula laudis breviter præstringam, si quis alius, vere Wiccamicus vocandus est, cum non solum ipse et postea duo eius filii sed olim pater atque avus in illustrissima Schola Beatæ Mariæ de Winton instituti sint. Ita per quattuor hominum ætates huius domus nomen in annalibus Wiccamicis notissimum. Nostræ mox Academiæ particeps et Collegii Corporis Christi alumnus duos fere et quinquaginta abhinc annos graduatus est.

In ὀρνιθολογίᾳ quam vocant hic profecto familiam ducit : hoc gubernante Societas Zoologica Britannica laude maxima floret ; horti autem Zoologici Londinenses nullis usquam cedunt. Quod ad doctrinam exquisitiorem et rei Zoologicæ peritiam attinet, illud potissimum dixerim, hunc regionum Zoologicarum naturam et limites primum perspexisse cum regionibus sex constitutis, Palæarctica, Nearctica, Neotropicali, Æthiopica, Orientali, Australi, orbem terræ non hominum civitatibus sed ferarum generibus partiretur. Quam rationem quinquaginta fere abhinc annos excogitatam plurimi ita emendare et corrigere conati sunt, quo in numero erat ipse Huxley, vir in hoc genere doctrinæ præstantissimus, ut etiam hodie probatissima et naturæ convenientissima esse videatur. Multa docuit hic vir ingeniosissimus quæ adhuc omnium iudicio comprobantur, velut Africæ septentrionalia harenosæ Nomadum solitudini superiacentia re vera Palæarctica esse atque Europæ affinia ; Arabiæ autem meridiana in regionem Africanam sive Æthiopicam cadere : de duabus etiam Americæ continentibus felicissime monuit, hanc ab illa dividi, non isthmo illo Panamensi, sed septentrionali Mexicæ latere, cum ultra citraque hanc quasi lineam accuratissime descriptam diversissima ferarum genera inveniantur.

SIR HENRY ROSCOE, F.R.S., has been elected Vice-Chancellor of the University of London for the ensuing year.

PROF. J. G. MACGREGOR, F.R.S., professor of physics in Dalhousie College, Halifax, Nova Scotia, has been elected to succeed Prof. Tait as professor of physics in the University of Edinburgh.

DR. F. H. NEWMAN, of the Royal College of Science, London, has been appointed director of technical education and principal of Tullie House, Carlisle. Tullie House consists of a public library, museum and school of art. It is the intention of the committee to build a technical school at an early date, the land having been already purchased. Dr. Newman commences his duties on July 1.

REPLYING to a question as to the terms of reference to the Royal Commission on University Education in Ireland, in the House of Commons on Thursday last, Mr. Balfour said they were as follows:—"To inquire into the present condition of the higher general and technical education available in Ireland outside Trinity College, Dublin, and to report as to what reforms, if any, are desirable in order to render that education adequate to the needs of the Irish people." The chairman is Lord Robertson, and among the other members are Profs. Ewing, Rücker and J. Lorrain Smith.

IN opening an exhibition of practical work done in connection with the City and Guilds of London Institute, at the Imperial Institute, Lord Avebury referred to the dependence of technological instruction upon the sound teaching of science, and some defects of school work in general, when considered from an educational point of view. He pointed out that our great public schools were bound under the regulations of the Public School Commission to give one-tenth of the marks in all examinations to science and one-tenth to modern languages. But this obligation was systematically ignored. At the greatest of our schools there were twenty-eight classical masters, thirteen mathematical, and only four science masters for more than 900 boys. The University of London, which he had the great honour of representing in Parliament for more than twenty years, had always taken a leading part in endeavouring to secure for science its proper place in our educational system. It was the first to give science degrees. It made a knowledge of science an obligatory part of the matriculation examination, that no University degree should be given to any one who, taking the line that literature, science and mathematics were necessary elements in any well-though-out education, was not well grounded in all three. It was difficult to over-estimate the important and beneficial effect which this had had on our secondary schools, and he deeply regretted that it had been proposed to drop science out of the list of obligatory subjects in the matriculation examination. It was greatly to be hoped that the Senate would not adopt a recommendation which was so retrograde and so opposed to the whole traditions of the University, and which he did not hesitate to say would be a national misfortune. The Chambers of Commerce did not wish, nor, he was sure, did scientific men wish, to exclude classics. What they pleaded for was that science, the knowledge of the beautiful world in which we lived, should not be excluded.

SCIENTIFIC SERIALS.

Bulletin of the American Mathematical Society, June.—The number opens with an account of the proceedings at the two April meetings of the Society. The Chicago section held its meeting at the University of Chicago on April 6. Ten papers were read, and abstracts of the papers are edited by Prof. T. F. Holgate. The other meeting was held in New York City on April 27. To relieve the increasing burden of administration, Dr. Edward Kasner was appointed assistant secretary, to serve until February 1902. This gentleman reports the proceedings and gives abstracts of several of the seventeen papers which were communicated.—The value of

$$\int_0^{\frac{\pi}{2}}(\log 2\cos\phi)^m\phi^n d\phi$$

is a notelet which was read before the April (1899) meeting of the Society by Prof. F. Morley.—Dr. Kasner's paper on the algebraic potential curves (read February 23, 1901) has for its object the derivation of the characteristic geometric properties of a class of curves which are of interest in connection with the theory of equations and of the potential function. Analytically, these curves are obtained by equating to zero the rational integral solutions $\phi(x, y)$ of Laplace's equation

$$\Delta\phi \equiv \frac{\partial^2\phi}{\partial x^2}+\frac{\partial^2\phi}{\partial y^2}=0,$$

or, what is equivalent, the real (or imaginary) parts of the rational integral functions of $x+iy$.—Various geometric properties are given in Briot and Bouquet's "Théorie des Fonctions Elliptiques" (book iv. chap. ii.), but none are completely characteristic. The several sections treat of (1) apolarity with respect to a point pair, (2) polar properties of potential curves, (3) focal properties, (4) the asymptotes, and (5) the connection with the theory of equations. Several useful references are given in footnotes.—The reviews are of Steinmetz's "Alternating Current Phenomena," by J. B. Whitehead, jun., and of de Tannenberg's "Leçons Nouvelles sur les Applications Géométriques du Calcul Differential," by L. P. Eisenhart.—The usual information follows in the notes and new publications.

American Journal of Science, June.—The new spectrum, by S. P. Langley. A short account of the methods adopted for mapping the spectrum in the ultra-red. The paper is accompanied with a map of this spectrum for wave-lengths between 0·76 μ and 5·3 μ.—On the rival theories of cosmogony, by O. Fisher. A discussion of the meteoric and nebular hypotheses. A study of some American fossil Cycads. Part iv. On the microsporangiate fructification of Cycadeoides, by G. R. Wieland. It was suggested in a previous paper that the sorus-bearing axis is a series of twelve fused leaves or fronds with their sorus-bearing pinnacles turned inwards. More extended study of additional material in a far superior state of preservation has confirmed the above hypothesis as a correct one.—Studies of Eocene mammalia in the Marsh collection in the Peabody Museum, by J. L. Wortman. A continuation of a previous paper.—On the cæsium-antimonious fluorides and some other double halides of antimony, by H. L. Wells and F. J. Metzger. A description of the mode of preparation and properties of five double salts of the composition $CsF.3SbF_3$, $CsF.2SbF_3$, $4CsF.7SbF_3$, $CsF.SbF_3$ and $2CsF.SbF_3$, mohawkite, by J. W. Richards.—The life-work of Prof. H. A. Rowland, by H. F. Reid.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 28.—"On the Results of Chilling Copper-Tin Alloys." By C. T. Heycock and F. H. Neville.

Sir W. Roberts-Austen and Dr. Stansfield have shown that the cooling curves of many copper-tin alloys exhibit well-marked "arrest points," or halts in the cooling due to the evolution of heat. From the temperatures at which these halts occur it is certain that many important changes take place long after the alloy has apparently become solid. Thus the authors find that an alloy of the composition $Cu_{81}Sn_{19}$ shows well-marked halts in cooling at the temperatures 754° C., 743° C., 558° C. and 490° C., the temperature at which solidification appears complete being but little below the second of the numbers. The exact nature of the changes causing the lower halts has until recently been obscure, but Prof. Roozeboom, by his paper on "Binary Systems Producing Mixed Crystals," has thrown much light on these phenomena.

The present paper is an attempt to apply Roozeboom's theory to the copper-tin alloys.

The authors, by slowly cooling small ingots of alloy to definite temperatures near the "arrest points" of the cooling curve, and then suddenly chilling them by immersion in water, have been able to prevent the subsequent changes due to slow cooling from taking place. The structures formed during the slow cooling down to the moment of chilling were thus fixed and could be examined.

It follows from Roozeboom's theory that in the solidification of a liquid mixture that can form mixed crystals the crystals first formed will generally differ in composition from the liquid, but that these crystals will change in composition as the solidification proceeds, and that in many cases at temperatures slightly below that of complete solidification the solid will consist of a uniform mass of mixed crystals. He further discusses the possibility of the solid solution thus formed breaking up into separate phases by crystallisation in the solid at lower temperature.

This paper contains photographs of three chills of the same alloy, $Cu_{81}Sn_{19}$, which illustrate these changes. In the first case the alloy was chilled at 740° C. (Fig. 1), while it was still partly fluid, and the photograph shows large primary combs much richer in copper than the mother substance.

Another portion of the same alloy was chilled at 630° C. (Fig. 2), a temperature at least 100 degrees below that of solidification. Even when etched or attacked in a variety of ways this sample shows no detail indicating any difference of composition; it appears to be homogeneous, or very nearly so. It has reached the stage of uniform mixed crystals.

Another fragment was chilled at 500° C. (Fig. 3), close to the lowest "arrest point." The photograph shows that crystallisation has taken place in the solid solution and that a substance rich in tin has crystallised in rosettes and bands, leaving a mother substance rich in copper.

These alloys, after polishing, were prepared for photography by slightly oxidising the surface by gently heating them in air, the temperatures needed to bring out the pattern in this way being far below those at which changes in the structure of the alloy occur. When treated thus, the parts rich in copper oxidise, and therefore darken, more rapidly than those rich in tin, hence the dark parts in the photographs correspond to matter rich in copper, and *vice versa.*

FIG. 1.—Chilled at 740°.

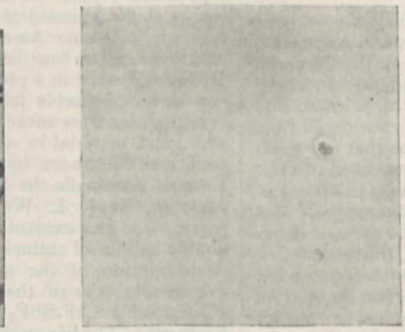


FIG. 2.—Chilled at 630°.

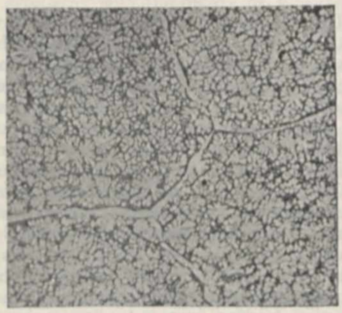


FIG. 3.—Chilled at 500°.

The authors have found similar, though sometimes more complex, phenomena throughout a considerable range of composition. The results lead to the conclusion that it is unwise to interpret a freezing curve by the examination of slowly-cooled alloys only.

May 2.—"On the Small Vertical Movements of a Stone laid on the Surface of the Ground." By Horace Darwin. Communicated by Clement Reid, F.R.S.

The experiments described in this paper were undertaken originally to measure accurately the downward movement of a stone caused by earthworms. The upward and downward movements due to varying moisture of the soil and to frost were found to be much larger than was expected. These movements, interesting in themselves, increase the difficulty of accurately determining the movement due to the action of earthworms.

To obtain a fixed point from which to measure the displacement of the stone a rod was driven into the ground to a depth of 2·63 metres. The top of this rod was the point from which all measurements were taken.

A circular stone about 460 mm. in diameter and about 57 mm. thick, weighing about 23 kilos., was placed on the ground with the rod projecting through a hole in its centre.

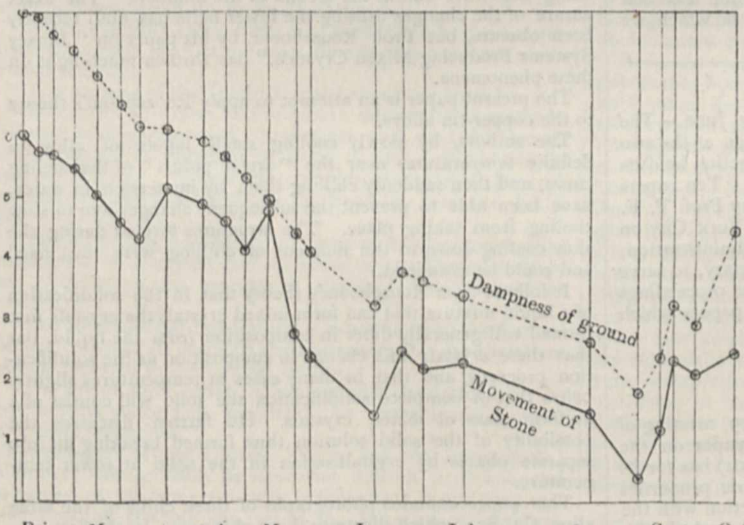
A screw micrometer graduated to ·01 mm. was used. The screw was turned until its end just touched the end of the rod ; owing to an unforeseen cause of error the measurements were not trustworthy to the last place of decimals. However, when care was taken to avoid this error, consecutive readings agreed to less than this amount, showing that the method was capable of greater accuracy than was required. Errors caused by the growth of the roots of a tree near the stone, swelling of the soil due to dampness, and the expansion of the rod from change of temperature are discussed.

The movements of the stone are represented graphically ; the figure reproduces one of the diagrams.

The curve marked "Movement of Stone" represents the up and down movements of the stone from February 19 to October 9, 1880, due to the varying dampness of the ground.

The points corresponding to each observation are surrounded by a small circle ; their vertical distance apart is proportional to the movement of the stone, each division of the scale representing 1 mm. ; the horizontal distance apart is proportional time.

The curve shown by the dotted line roughly represents the dampness of the soil. Moisture is assumed to leave the soil at a uniform rate ; the ordinates are proportional to the rainfall less this assumed amount evaporated or drained away ; both quantities are calculated from February 19. The curves follow each other, showing that the stone fell as the soil became dryer and rose again with rain. In May there is a marked exception ; the most probable explanation is an error in reading the micrometer. The total downward movement from February 19 to September 7 is 5·6 mm. On another occasion artificially wetting the ground raised the stone 0·6 mm.



Measurements taken in the winters of 1878 and 1886 show that the stone sank about 2·2 mm. per year. Measurements were also taken in the summer of most years from 1878 to 1896. The downward movement was not regular, and it is shown that this also is partially due to the varying dampness of the soil. From 1878 to 1887 the stone sank on the average about 2·3 mm. per year, and from 1887 to 1896 about ·36 mm. per year.

The effect of frost is to raise the stone ; it fell rapidly during a thaw—on one occasion 2·3 mm. in 4 hours 40 minutes.

June 6.—"The Measurement of Ionic Velocities in Aqueous Solution, and the Existence of Complex Ions." By B. D. Steele, B.Sc., 1851 Exhibition Scholar (Melbourne). Communicated by Prof. Ramsay, F.R.S.

The method of measuring ionic velocities described by Masson has been extended in such a manner that, by the present method, the use of gelatin solution and of coloured indicators is not necessary.

An aqueous solution of the salt to be measured is enclosed between two partitions of gelatin which contain the indicator ions in solution, the apparatus being always so arranged that the heavier solution lies underneath the lighter. On the passage of the current the ions of the measured solution move away from the jelly, followed at either end by the indicator ions ; the boundary is quite visible in consequence of the difference in refractive index of the two solutions. The velocity of movement of the margins is measured by means of a cathetometer, and the ratio of the margin velocities gives at once the ratio of the ionic velocities.

The velocities of a large number of ions at different concentrations of different salts have been calculated, and the velocities of the hydrogen and hydroxyl ions have been also measured, with the following results:—

	Found.	Calculated.
OH in KOH, 0·5 N	0·001435	0·00145
,, NaOH, 0·2 N	0·00158	0·00152
H in HNO_3, 0·2 N	{ 0·00282 / 0·00272 }	0·00280

The ratio of the current, as measured by the galvanometer, to that calculated from the velocity of the margins in the manner indicated by Masson, is found to be equal to unity only for a few salts of the type of potassium chloride; for other salts this ratio has a value in some cases greater, in others less, than 1. The same irregularity has been previously pointed out by Masson for the gelatin solutions of the sulphates of magnesium and lithium.

The attempt is made to explain this deviation from the requirements of theory, and also the difficulty that Kohlrausch is unable to assign to dyad elements any value for the specific ionic velocity, which is the same when calculated from the measurements of different salts of the same metal, by the assumption, first advanced by Hittorf, that, in concentrated solutions of these salts ionisation takes place in such a manner that there are formed complex ions in addition to simple ones; and the conclusion is drawn that, in all cases where any considerable change in transport number occurs with changes in concentration, complex ions are present to a greater or less extent.

Zoological Society, June 4.—Dr. W. T. Blanford, F.R.S., vice-president, in the chair.—A communication by Dr. R. Broom, on the structure and affinities of the Anomodont genus Udenodon, was read. It contained an account of a number of specimens from the Lower Karoo beds of Pearston, South Africa, which the author referred to the Dicynodont genus Udenodon [Oudenodon]. One of these, a small skull, was shortly described as the type of a new species (*U. gracilis*).—A communication was read from Mr. Oldfield Thomas, F.R.S., in which he gave the history of the specimen of *Rhinoceros lasiotis*, Sclater (which had lived for thirty-two years in the Society's Gardens), and stated that he was of opinion that it was not deserving of specific rank, but should be considered rather as a subspecies of *R. sumatrensis*. The generic nomenclature of the rhinoceros was also examined, and it was proposed that the existing species of this family should be divided into three generic divisions—Rhinoceros (to include *R. unicornis* and *R. sondaicus*), Dicerorhinus (to include *R. sumatrensis* and *R. sumatrensis lasiotis*), and Diceros (to include *R. simus* and *R. bicornis*). It was shown that, if it were found necessary to divide the species *R. simus* and *R. bicornis*, the former, with its fossil allies, should bear the name Coelodonta.—Mr. G. A. Boulenger, F.R.S., read a paper on a small collection of fishes from the Victoria Nyanza which had been made by the order of Sir H. H. Johnston, K.C.B. Six species were enumerated and remarked upon, two of which (*Labeo victorianus* and *Discognathus johnstoni*) were described as new.—Mr. F. E. Beddard, F.R.S., described six new species of earthworms of the genus Benhamia from Tropical Africa.—A communication was read from Mr. J. G. Millais containing some notes on the capture of a specimen of Bechstein's Bat (*Vespertilio bechsteini*) in the neighbourhood of Henley-on-Thames. So far as was known, this was only the second occurrence of this species recorded in Great Britain.—Mr. H. R. Hogg read a paper on the Australian and New-Zealandian spiders of the suborder Mygalomorphæ. The author adopted the nomenclature of M. Simon, and stated that of the seven subfamilies of this suborder into which M. Simon had divided it, six were represented in Australia and New Zealand, the only absentee being the Paratropidinæ of South America.

Entomological Society, June 5.—The Rev. Canon W. W. Fowler, president, in the chair.—Mr. G. C. Champion exhibited a male specimen of *Odontaeus mobilicornis*, one of the rarest of British beetles, captured at Woking on May 28.—Mr. R. McLachlan exhibited four specimens of a curious bug of the genus Henicocephalus received from Mr. G. V. Hudson of Wellington, New Zealand, not previously noticed in that country. Mr. Champion said that Henicocephalus was generally recognised as a type in itself of a family, and Mr. Kirkaldy that it was much commoner than generally supposed. It was probably only an aberrant form of the Reduviidæ, having no stridulating apparatus on the prosternum.—Mr. C. P. Pickett exhibited varieties of *Smerinthus tiliae* bred during May 1900-1.—Mr. C. G. Barrett exhibited imagines, cocoons, pupa skins, and also water-colour sketches of larvæ, reared and drawn by Miss Frances Barrett, at Buntingville, Pondoland, S. Africa.—Dr. A. Jefferis Turner exhibited specimens of Australian wood-boring Lepidoptera belonging to four different families. They included examples of Pyralidæ, Gelechidæ, Cossidæ and Hepialidæ.—Mr. H. Goss exhibited for Mr. Ernest Ardron, of Colombo, Ceylon, two specimens of a species of Phyllium (Phasmidæ). They bore an extraordinary resemblance to leaves. He also showed three varieties of the male of *Melitaea Cinxia*, which he had taken on May 27 and 28 at Niton, Isle of Wight.—Mr. C. O. Waterhouse exhibited two new genera and species of Coleoptera recently described by him in the *Ann. and Mag. Nat. Hist.* from Rio Janeiro. One belonged to the aberrant Prisnidæ (*Pathocerus Wagneri*); the other (*Tetraphalerus Wagneri*) belonged to the Cupesidæ, and was remarkable for the form of its head. He also exhibited ♂ and ♀ of the curious Scarabæid, *Glyphoderes sterquilinus*, Westw., from North Argentina.—Mr. H. St. J. Donisthorpe exhibited a glove burnt by discharges of formic acid in the nests of *Formica rufa*. Prof. Poulton said that the discharges collected in tubes fluctuated greatly in strength, the strongest yielding a proportion of sixty to seventy per cent. of anhydrous acid. The discharge of *Dicranura vinula* showed a strength of about forty-five per cent.—Mr. W. Schaus communicated "A Revision of the American Notodontidæ," and Mr. H. St. J. Donisthorpe read a paper on cases of protective resemblance, mimicry, &c, in British Coleoptera.

Linnean Society, June 6. Mr. W. Curruthers, F.R.S., vice-president, in the chair.—The adjourned debate was resumed on Mr. H. M. Bernard's paper on the necessity for a provisional nomenclature for those forms of life which cannot be at once arranged in a natural system.—The following resolutions were proposed by Mr. Bernard: (1) That the Linnean method of naming is well adapted for indicating affinity, and should be used for that purpose; (2) that allied forms whose affinities are not clear should be designated by some provisional method of naming; (3) that the method proposed by the author appears to promise enough to justify its temporary application to the Anthozoa. Mr. H. Groves moved as an amendment to the first resolution to omit all after the word "naming," and to substitute "is adequate for the present needs of zoology and botany." This was seconded by Dr. P. L. Sclater. The discussion was continued in order to elicit the views of those present on the resolutions proposed by Mr. Bernard, but no vote was taken.

Anthropological Institute, June 11.—Dr. A. C. Haddon, F.R.S., president, in the chair. Mr. Morton Middleton exhibited, on behalf of the South American Missionary Society, a large series of implements and other objects, including swan gullet necklaces, whalebone snares, featherwork, &c., from the Yahgans of Tierra del Fuego, and introduced Mrs. Burleigh, who spent some fifteen years among the Yahgans, and gave a number of additional data in regard to them.—Mr. G. Coffey read a paper on Irish copper celts.

Mathematical Society, June 13.—Dr. Hobson, F.R.S., president, in the chair.—The theory of Cauchy's principal values (ii.), by Mr. G. H. Hardy.—On the general form of three rational cubes whose sum is a cube, by Prof. Steggall.—Invariants of curves on the same surface, in the neighbourhood of a common tangent line, by Mr. T. Stuart.—Short impromptu communications were made by Dr. Macaulay (2) and Lieut.-Colonel Cunningham, R.E.

DUBLIN.

Royal Irish Academy, June 10.—The president in the chair.—On the creeping of liquids and tension of mixtures, by Dr. Fred T. Trouton, F.R.S. A number of experiments were described which showed that in order for a liquid to be capable of creeping over solid surfaces it must be a mixture. Ordinary paraffin, for example, does so, but a pure paraffin will not creep. It can be made to do so, however, by the addition of a suitable liquid. The added liquid must be more volatile, and must reduce the surface tension. This can be the case not only with liquids of lower surface tension, but also with liquids of higher surface tension when added in small quantities. For experiments on mixtures of liquids in general showed that the surface tension of a mixture is always less than the percentage calculated value. Thus an actual depression of the surface tension is in most cases produced by adding a liquid of higher surface tension. For this reason there are few liquids by the addition of which the creeping of, say, ordinary paraffin may be prevented, the requisite being a more volatile liquid with a very high surface tension.

EDINBURGH.

Mathematical Society, June 14.—Mr. J. W. Butters, president, in the chair. The following papers were read: (1) Note on an extension of Abel's theorem on the continuity of a power series, by Prof. Gibson; (2) The diffraction of plane waves incident obliquely on a semi-infinite plane, by Dr. Carslaw.

PARIS.

Academy of Sciences, June 17.—M. Fouqué in the chair.—Researches on chemical equilibria. The formation of insoluble phosphates by double decomposition; disodium hydrogen phosphate and silver nitrate, by M. Berthelot. In the reaction between silver nitrate and ordinary sodium phosphate, the total precipitation of the silver as phosphate takes place only when the two salts react in equimolecular proportions. Precipitates formed in the presence of an excess of sodium phosphate contain a certain amount of sodium, probably in the form of a sodium silver phosphate, which cannot be removed by prolonged washing.—On some new syntheses effected by means of molecules containing the methylene group associated with one or two negative radicles. The action of epichlorhydrin and epibromhydrin upon the sodium derivatives of benzoylacetic esters, by M. Haller. The chlorine or bromine atom is not eliminated in these reactions, but an addition product is formed. Thus epichlorhydrin with benzoylacetic ester gives a new ketolactone, the properties and reactions of which are given.—M. Maupais was nominated a correspondent for the section of anatomy and zoology in the place of the late M. Marion.—Some new nebulæ discovered at the Observatory of Paris, by M. G. Bigourdan. Positions and descriptions of twenty-one new nebulæ.—On the employment of the stereoscope in astronomy, by M. Maurice Hamy. Remarks on some possible applications of the stereoscope in astronomy, with applications to the study of the motions of stars by the Doppler-Fizeau principle, to eclipses of the sun with special reference to the internal movements of the chromosphere, and to the internal movements of nebulæ.—The equations and fundamental properties of reciprocal autopolar figures in the plane and in space, by M. Rabut.—On Fourier's series, by M. A. Hurwitz.—On the application of the theory of elasticity to the calculation of bent rectangular beams, by M. Mesnager.—On electromotive forces of contact and the theory of ions, by M. E. Rothé. An experimental study with a Lippmann capillary electrometer in which the solution could be readily changed, the solutions used being sulphuric and hydrochloric acids of varying strengths. The variations of electromotive force thus observed were compared with those calculated from the ionic hypothesis, the agreement in the case of the weak solutions being satisfactory.—The capillary constants of organic liquids, by MM. Ph. A. Guye and A. Baud. Measurements by the method of Ramsay and Shields of the capillary constants of phenetol, anisol, ethyl acetate, nitrobenzene, benzonitrile and metacresol. In all these substances, with the exception of metacresol, the value of the constant K exceeds the number 2·121 admitted by Ramsay and Shields as the value for a non-polymerised liquid, but the author adduces reasons for supposing that this does not necessarily mean that these substances are in a polymerised state.—On a new element, europium, by M. Eug. Demarçay. By a prolonged fractionation of samarium it has been possible to isolate the oxide of an element, apparently distinct from samarium, and which is capable of giving rise to the so-called anomalous ray, discovered by Crookes in the fluorescent spectrum of samarium. It is also identical with the element provisionally named *Zε* by de Boisbaudran. The name europium is proposed for this substance, with the symbol Eu = 151 about.—On the chlorobromides of thallium, by M. V. Thomas. The methods of preparation and the properties of two chlorobromides of thallium are described, having the compositions $Tl_3Cl_2Br_4$, and TlClBr.—The reactions of acetylene with cuprous chloride dissolved in a neutral solution of potassium chloride, by M. R. Chavastelon. The action of acetylene upon a neutral saturated solution of cuprous chloride gives the same results as when the solution is acid or alkaline.—The separation of nickel and cobalt by the electrolytic method, by M. Dmitri Balachowski. From a solution containing both nickel and cobalt salts to which ammonium thiocyanate, urea, acetic acid, and a little ammonia have been added, it has been found possible by careful attention to the voltage, and especially to the amperage, to completely separate the nickel, which comes down apparently as a sulphide. By then altering the voltage and the strength of the current the cobalt can be thrown out.—Study of contact action on the secondary and tertiary alcohols, by M. A. Trillat.—On the floral organogenesis of the disciflora, by M. L. Beille.—Diffusion in gelatin, by M. S. Leduc.—On the presence of carbon monoxide in the blood of the newly-born, by M. Maurice Nicloux. In ten estimations of the amount of carbon monoxide in the blood of a newly-born animal the amount found varied between ·08 c.c. to ·14 c.c. of CO from 100 c.c. of blood, with a mean of 0·11 c.c. The amounts were estimated by the amount of iodine set free from iodic acid, and from this reaction and the fact that the gas is totally absorbed by hæmoglobin it is quite certain that the gas is really CO.—On a biochemical differentiation of the two principal ferments of vinegar, by MM. Gab. Bertrand and R. Sazerac. The two species, *Mycoderma aceti* and *Bacterium xylinum*, can be distinguished by their different oxidising power towards glycerin.—On the extrapolar electrotonic currents in nerves without myeline, by M. Mendelssohn.—On the reaction time in different races and social conditions, by M. Louis Lapicque. The average reaction time of Europeans was found to be 0·15 second, of Hindoos 0·22 second and of Andaman Islanders 0·19 second.—The influence of the lethecines of the egg upon the nutritive changes, by MM. A. Desgrez and A. Zaky.—On the use of yeast as a means of finding out communications between sheets of water, by M. P. Miquel.

CONTENTS.